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ORIGINAL ARTICLES.

I.—On Homœomorphy among Fossil Plants.

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STUDENTS of palæobotany, when concerned with casts and impressions of fossil plants as distinguished from petrifactions, have often to face difficulties in the course of their examination of such remains, some of which are peculiar to this branch of palæontology. Even when a large number of specimens of any particular type of foliage, or other organs, are available for comparison, it is often difficult to decide how far one set of casts and impressions can be regarded as distinct from another. Authorities differ in their ideas of the aggregate of differences necessary to constitute genera and species. This difficulty, although common to the systematist in the study of recent plants, is greatly intensified when dealing with fossils, on account of the fragmentary nature of the evidence.

To take an illustration. Among Upper Carboniferous fern-like plants none are perhaps more frequent in British rocks than *Neuropteris* and *Alethopteris*, types of foliage in all probability belonging to members, not of the true ferns, but of the Cycadofilices. In these genera the habit of the frond is extremely well marked and characteristic, and they are regarded as good form-genera. But there also occur, frequently in the Continental Coal-measures, though more rarely in the Carboniferous rocks of this country, two other genera, *Linopteris* (also known as *Dictyopteris*) and *Lonchopteris*, which correspond exactly with *Neuropteris* and *Alethopteris*, respectively, except in one remarkable detail. In *Linopteris* and *Lonchopteris* the secondary nerves of the pinnules anastomose among themselves, forming a regular network, whereas in the genera first mentioned no such reticulations occur. This parallelism extends also to species within the genera. As Zeiller[1] has pointed out, *Linopteris Brongniarti*, Gutbier, corresponds closely

[1] Zeiller: "Éléments de Paléobotanique," 1900, p. 108.

in habit to *Neuropteris gigantea*, Brong., and *L. Germari* (Giebel) to *N. heterophylla*, Brong. The question arises how far the presence or absence of a single character, such as the anastomosis of the secondary nerves, should be regarded as of systematic value.

To take another illustration. In the Permo-Carboniferous rocks of India and the Southern Hemisphere there occur an abundance of fronds of two genera, *Glossopteris* and *Gangamopteris*. According to our present knowledge, the latter differs from the former, at least in the commoner species, only in the absence of a midrib, a character which we also know is not present in all fronds of undoubted Glossopterids.[1] Etheridge[2] has pointed out how closely certain fronds of these two genera resemble one another. What weight should therefore be given to a single point of difference, such as the presence or absence of a midrib?

Often also plants from widely separated areas, which may or may not be contemporaneous, bear a close resemblance to one another, although definite characters may exist which clearly distinguish them. This is the case with *Aneimites ovata* (McCoy) from Arowa, New South Wales (?Carboniferous), which so closely resembles *Rhacopteris inæquilatera* (Goepp.), a well-known British Lower Carboniferous plant, that it is a matter of dispute whether the two are not identical.[3]

Many other instances might be quoted. In *Dictyozamites*, a Lower Oolite genus recently described from Britain for the first time by Mr. Seward,[4] we have an interesting case of parallelism with *Otozamites*. Professor Zeiller[5] has also recently pointed out that the genus *Rhiptozamites* of Schmalhausen represented in the Permian of Russia may eventually prove to be distinct from the *Noeggerathiopsis* of Gondwana-land, which it so closely resembles.

These are illustrations of a common difficulty constantly present in palæobotanical study. Before further light is thrown on the affinities of such plants by the discovery of their fructifications, discoveries which will often in themselves remove the difficulty, it would appear that any help which can be given as to the meaning of these similarities of habit would be welcome. Such guidance may, I think, be found in recent progress in other branches of palæontology, especially in the elucidation of the Rhabdophora and the Jurassic Brachiopoda.

In an interesting paper published in the Quarterly Journal in 1895, Mr. S. S. Buckman[6] pointed out that in the Jurassic Brachiopods, and also to some extent in the Ammonoidea, close resemblances occur between species of different origin and descent.

[1] Zeiller, Bull. Soc. géol. France, ser. III, vol. xxiv (1896); Seward, Q.J.G.S., vol. liii (1897), p. 318; Arber, Q.J.G.S., vol. lviii (1902), p. 9.
[2] Etheridge, jun.: Proc. Linn. Soc. N.S. Wales, ser. II, vol. ix (1894), pp. 240–1.
[3] Arber, ibid., p. 21; Kurtz, Q.J.G.S., vol. lix (1903), pp. 26 and 28.
[4] Seward: Q.J.G.S., vol. lix (1903), p. 217.
[5] Zeiller: Compt. rendu Acad. Sci., t. cxxxiv (1902), pp. 887–891.
[6] S. S. Buckman, "The Bajocian of the Mid-Cotteswolds," Appendix, 'Note on certain Brachiopoda': Quart. Journ. Geol. Soc., vol. li (1895), p. 456.

In a second paper,[1] published in 1901, a further account was given of very striking examples of parallelism of development among these fossils, which has resulted in the production of homœomorphs, and of the phenomenon of homœomorphy. Mr. Buckman has further shown that "various species of different stocks may either produce these developmental characters more or less contemporaneously, in which case such forms are called isochronous homœomorphs, or they may produce the characters at different dates—a later form simulating an earlier one—in which case they are called heterochronous homœomorphs."[2] The conception that two genera of distinct ancestry may, by parallelism of development, evolve a series of characters common to the two, which, as it were, overshadow their distinctive and ancestral characters, throws a flood of light upon difficulties such as those here described.

Almost immediately after the publication of Mr. Buckman's first paper, Messrs. Nicholson & Marr[3] showed that the same hypothesis holds good for the Graptolites, and will "explain the more or less simultaneous existence of forms possessing the same number of stipes, but otherwise only distantly related, if we imagine them to be the result of the variation of a number of different ancestral types along similar lines."[4]

This conception is, however, something more than a working hypothesis, for both Mr. Buckman, in the case of Jurassic Brachiopoda, and Messrs. Nicholson & Marr with regard to the Graptolites, have been able to trace out the steps whereby two lines of descent converge towards homœomorphy, and the theory of homœomorphy has thus already won considerable acceptance.

It has seemed to me that the hypothesis of homœomorphy may be of great service as a guide to the systematist in difficulties such as I have just described among fossil plants, as it has been found to be in other branches of palæontology. In such genera as *Neuropteris* and *Linopteris* some support may be found for such a view, but in the present state of our knowledge of fossil plants I very much doubt whether it is possible to demonstrate a series of intermediate types similar to those brought forward in regard to the Brachiopoda and Graptolites. It would, however, seem certain that if the phenomenon of homœomorphy is constantly borne in mind, that many and excellent proofs will be obtained as our knowledge of fossil plants increases. For the present, however, the theory as applied to fossil plants must remain as little better than a working hypothesis, the truth of which would seem to be exceedingly probable. Even now we are not without evidence in support of this view, for homœomorphy is exceedingly common among living plants. It is, of course, well known that many recent plants of the most diverse origin show strong superficial resemblances. We

[1] S. S. Buckman, "Homœomorphy among Jurassic Brachiopoda": Proc. Cotteswold Naturalists' Field Club, vol. xiii (1901), p. 231.

[2] Buckman: ibid., pp. 232–3.

[3] Nicholson & Marr, "Notes on the Phylogeny of the Graptolites": Geol. Mag., n.s., Dec. IV, Vol. II (1895), p. 529.

[4] Ibid., p. 537.

also know that in the vast majority of cases these are not true mimetic resemblances, as occur in the animal kingdom, but adaptations to common conditions of the environment. Numerous instances might be quoted, but it may serve to mention the fleshy succulent stems of such Xerophytes as *Euphorbia* (Euphorbiaceæ), *Cactus* (Cactaceæ), and *Stapelia* (Asclepiadaceæ), and the much divided leaves of such hydrophilous plants as the Batrachian *Ranunculi* (Ranunculaceæ), *Myriophyllum* (Haloragidaceæ), and *Hottonia* (Primulaceæ).[1] Indeed, it is fully recognised that plants which are highly adapted may, if found fossil, become a fruitful source of error to the palæobotanist.[2]

If, therefore, the theory of homœomorphy is permissible as a working hypothesis applicable to fossil plants, then we have not only some explanation of the phenomenon "of similarity in general with dissimilarity in details,"[3] which is common among such remains, but an indication of the possible diverse origin of such types. At the same time, it is necessary to guard against an undue application of a criterion of small differences, and consequently a large increase to the number of genera and species already recorded. It is necessary to remember that such small differences may be really due to the manner of preservation. But where good characters do exist, however much they may be overshadowed by general resemblances, the adoption of the theory of homœomorphy, even though it may not in all cases be a safe guide, would usually point to separation rather than to identification.

II.—On a Fossiliferous Bed in the Selbornian of Charmouth.

By W. D. Lang, B.A., British Museum (Nat. Hist.).

THE Charmouth district, situated in the south-west corner of Dorsetshire, consists of valleys in the Lias clays, separated by hills which are capped by Upper Cretaceous rocks, resting unconformably upon the Lias. Black Ven is the name of the cliff face bisecting one of these hills, which, lying between Charmouth and Lyme Regis, divides the valleys of the Char and the Lyme stream. Of this cliff, the lower 350 feet consist of Lias clays and limestones. Above this the succession of beds is explained by the following section:—

		Feet.
	4. Soil and subsoil, consisting chiefly of the weathered remains of the Chert beds in the zone of *Peeten asper*, as well as of higher Cretaceous beds	about 20
Zone of *Schloenbachia rostrata* (Sowerby).	3. Yellowish-brown sand (Foxmould)	60–80
	2. Yellow sand containing three layers of indurated nodules (Cowstones)	30–50
Zone of *Hoplites interruptus* (Bruguière).	1. Black and dark green loams	20

[1] For a short account of these biological groups see Henslow, *Natural Science*, vol. xv (1899).

[2] Seward: "Fossil Plants," vol. i, chapter v. [3] Buckman: ibid., p. 232.

The fossil-bed here described was first found by the author in April, 1901, and fossils from it have been obtained on several subsequent occasions.

So far as can be determined the bed has not yet been described, though it may have been mentioned by Mr. A. J. Jukes-Browne in dealing with the Gault and Upper Greensand of England.[1] He speaks of "the highest visible bed" at Black Ven as being composed of "brownish sand with green grains and many broken shells of *Pecten* (*Neithea*) *quadricostata*, recalling sand seen at Foxton, near Chard." Further than this he does not describe it, and I am inclined to think that he refers to a bed at the top of the cliff, immediately under the Golf Links, about half a mile further westwards. Otherwise he could not have failed to mention the number of other fossils, notably *Exogyræ*, with which the *Neithea* fragments are associated.

Mention is also made in the same place of "a nest of silicified but fragmentary fossils, ... resembling very poor Blackdown specimens," found by the Rev. W. Downes in 1884.[2] But on referring to Mr. Downes' paper it seems that the fossils he found were at least a quarter of a mile further west; for he describes them as occurring "50 feet above the spot in the Gault where I obtained the other fossils, and in nearly a straight vertical line above it." Tracing this line from where Gault fossils are *now* exposed, we reach a locality where there is no section, although cliffs are present on either side of this spot, the junction of the old and present Lyme roads. As the present road had only been made four years previously to Mr. Downes' paper, it is probable that these cliffs were then much less overgrown, and possibly his fossil-bed is the same as that described below, appearing further westwards, which (if there) is now hidden by overgrowth and talus. Even so, it will be seen by the section following that the latter is considerably more than 50 feet above the black Gault loams.

At a height of from 370 to 400 feet the road at present used between Charmouth and Lyme has been made for some distance along the face of the cliff, passing along the lower part of the zone of *Schloenbachia rostrata* (Sowerby), which consists of yellow sands locally called 'Foxmould.' This Foxmould forms a cliff of varying height overhanging the roadway, and at a spot situated some one and a half miles from Lyme Church, and about half a mile from Charmouth Church there is a small cliff on the seaward side of the road. This cutting is called by the villagers the 'Devil's Bellows,' on account of the great force with which a gale blows through it, facing as it does the south-west. The inland cliff is 75 feet in height, and the main fossil-bed occurs at a height of about 50 feet.

The following section, measured in September, 1902, gives a general idea of the beds of which the Foxmould consists. The small divisions, however, probably thin out rapidly in all directions, and so are of no use in correlating the beds from hill-top to hill-top.

[1] A. J. Jukes-Browne: "The Gault and Upper Greensand of England," 1900, p. 186.

[2] W. Downes, "The Cretaceous Beds at Black Ven, near Lyme Regis": Quart. Journ. Geol. Soc., vol. xli (1885), p. 23.

SECTION AT THE CUTTING, CHARMOUTH.

Scale, 1 foot = ·076 inch.

Feet above sea-level.			ft.	ins.	
450	0	Weathered remains of Chert beds, i.e. lower half of zone of *Pecten asper*, consisting of angular Chert fragments, in a sandy matrix	20	0	Chert beds = remains of zone of *Pecten asper*.
431	0	Very dark green, loamy, glauconitic sand, veined with purplish-black and pink-red iron oxide 12	0	5	'Foxmould' = upper portion of zone of *Schlotheimia rostrata*.
		Greenish-brown glauconitic sand, with occasional veins of purplish-black iron oxide, and occasional obscure fossil remains 11	0	15	
429	0	Reddish and brown glauconitic sand, crowded with fragmentary shells, chiefly *Exogyra* and *Neithea*, and bits of Chert 10	0	6-8	
426	6	Same as bed 11. Greenish-brown glauconitic sand, with occasional veins of purplish-black iron oxide, and occasional obscure fossil remains .. 9	2	6	
425	8	Whitish and yellow glauconitic sand, with fragmentary shells in Beekite, and casts in purple-black iron oxide, and specks of purple-black iron oxide 8	0	10	
422	8	Same as bed 8, with no or few fossils 7	3	0	
421	0	Same as beds 8 and 9, with many fossils in Beekite, and casts in purple-black iron oxide 6	1	8	
419	0	Salmon-pink and white glauconitic sand, with flecks of purplish-black iron oxide 5	2	0	shown.
		Broken ground	6	0	
413	0	Yellow and white glauconitic sand with occasional obscure fossil remains, and a little iron oxide 4	17	0	
396	2	Darker yellow and white glauconitic sand, with occasional obscure fossil remains 3	6	6	
389	8	Yellow and white glauconitic sand veined with black clay 2	2	8	
387	0	Reddish-yellow glauconitic sand 1	4	0	shown.
383	0	Broken ground	10	0	
373	0				

West. Roadway—Charmouth to Lyme. *East.*
To Lyme 1½ miles. To Charmouth ¾ mile.

It will be seen that there is a gap of 6 feet in the middle of the section where no sand is exposed, the cliff being here obscured and overgrown with grass, gorse, and broom.

Of the three beds in which fossils occur, the uppermost (No. 10) is by far the most productive, the lower two beds (Nos. 6 and 8) yielding chiefly *Exogyræ*; moreover, these are not so well preserved as those in the highest bed.

The fossils obtained from the bed (No. 10) are as follows. The numbers after the names indicate the number of specimens found :—

Mollusca Lamellibranchiata.

Alectryonia frons (Parkinson), 2.
? *Anomia* sp., 1.
Avicula sp., 1.
Exogyra canaliculata (Sowerby), 1.
Exogyra conica (Sowerby), abundant.
Exogyra plicata (Lamarck), 2.
Ostræa sp., 1.
? *Pecten* (*Syncyclonema*) *orbicularis*, Sowerby, 1.
Pecten (*Neithea*) *quadricostata*, Sowerby, abundant.
Septifer lineatus (Sowerby), 1.

Mollusca Gasteropoda.

Turbo sp., 1.

Annelida.

Serpula ilium, Sowerby, 2.
Serpula filiformis, Sowerby, 2.

Echinodermata.

One Urchin spine.

Bryozoa.

Cellulipora ornata, D'Orbigny, var. *devonica*, Gregory, 1.
Entalophora sp., 1.
Entalophora (?), 1.
Ceriopora (?), 1.

The following is a list of the fossils found by Mr. Downes [1] :—

Mollusca Lamellibranchiata.

Cardium proboscideum, Sowerby, 3 small fragments.
Cucullæa fibrosa, Sowerby, 1.
Cucullæa glabra, Sowerby, 4.
Cyprina cuneata (Sowerby), abundant.
Cytherea caperata (Sowerby), 4.
Gervillia rostrata (Sowerby), abundant.
Exogyra, 1.
? *Pecten orbicularis*, Sowerby, 1.
Pecten quinquecostatus, Sowerby, fragment.
Trigonia scabricola, Lycett, 2.

Mollusca Gasteropoda.

? *Phasianella* sp., 1.
Turritella granulata, Sowerby, 1.

Annelida.

Serpula sp.

Porifera.

? *Siphonia*.

[1] Downes, ibid., p. 25.

The *Pecten quadricostatus*, Sowerby, and the *Exogyræ* are by far the commonest shells, the Pectens being mostly fragmentary; but I have found nearly perfect ones, which, however, have invariably fallen to pieces on being removed.

All the fossils are siliceous, many, especially the flat fragments of *Pecten*, showing the curious concentric structure peculiar to Beekite.

The obscure fossil remains in beds 3 and 4 are casts in sand, which at once fall to pieces on removal; but none of those found could be identified. Possibly they are the 'impressions' mentioned in the Survey Memoir.[1]

Half a mile further westwards, where the Foxmould cliff recedes some two hundred yards from the road, and immediately beneath the Golf Links, another fossil-bed occurs. This, like the last, lies within a foot of the capping of chert detritus, but is at a higher level, the cliff rising here to about 500 feet. This has yielded fragments of *P. quadricostatus*, Sowerby, and from it in September, 1902, I obtained some fine specimens of *Exogyra conica*, Sowerby.

My best thanks are due to Dr. F. L. Kitchin and Mr. E. T. Newton, F.R.S., of the Museum of Practical Geology, for their kindness in helping me to identify the specimens.

III.—Some Disputed Points in the Crystallisation of the Constituent Minerals of Granite.

By A. R. Hunt, M.A., F.G.S.

In writing my little paper on vein-quartz I was particularly anxious not to introduce controversial matter, but to be strictly orthodox throughout. After the paper was published I was much perturbed to find that I had unwittingly come into collision with two incidental remarks in General McMahon's most interesting paper on the Satlej granite, which was the subject of his address to Section C at Belfast. My oversight arose owing to the said remarks being incidental, and no stress having been laid upon their paramount importance.

To explain, the modern theory of granite is a chemico-physical one, founded on the critical temperatures of carbonic acid and of water. According to the physical evidence, ordinary granites crystallised about the critical temperature of water; some minerals possibly above, and others below; or all above, or all below. The critical temperature of water I have taken as 342° C. (Rep. Brit. Assoc., 1877, p. 236). The chief witnesses are the various inclusions of gas, water, and other liquids, and the deposited crystals contained in the water inclusions.

In my paper I assumed it to be an accepted fact that deposited crystals were proof positive that the mineral containing them was crystallised below the critical temperature of water, and that groups of inclusions with proportional amounts of carbonic acid and water were evidence of a temperature above the critical temperature of water. I also assumed that above the critical temperature of water,

[1] Jukes-Browne: ibid., p. 186.

water could not exist as a liquid, whatever the pressure; for that, as I understand it, is the meaning of the term critical temperature, or critical point.

Now, on carefully studying General McMahon's paper, I find that, after deducing an approximate temperature of the Satlej magma from the fusion temperatures of the individual minerals, of which he tells us beryl was the first to crystallise, at a temperature approaching 1,200° C., he further tells us that the beryl contains water inclusions with deposited crystals, and gas inclusions. The General further describes water as being held by pressure in a liquid state, in the more than red-hot magma.

These statements are not only inconsistent with the old physical theory of granite, but entirely subversive of it. On reviewing my paper in the light of General McMahon's address, I found that the question at issue could be indirectly reduced to a single point, which involved (if a point which has no magnitude can be said to involve) all the others. That point is the correctness or otherwise of Professor Hartley's conclusions as to the crystallisation of topaz. I thought it the better plan to refer the question at once to Professor Hartley, and enquire whether in the last twenty-five years he had seen any reason for reconsidering his conclusions as to topaz. If the answer were in the affirmative I would withdraw my paper without reserve. But Professor Hartley has been good enough to reply to my enquiry, and the answer is in the negative. Thus I find myself once more in the hopeless situation of the crock between the pot and the kettle.

Many of the readers of the Magazine must, I am sure, be golfers, and I am confident I may rely on their sympathy as being the mere captain of a golf club with a couple of antiquated microscopes, and far more competent to write an article on mashie approaches and putting than on the consolidation of granitic minerals. They will also agree that mashie approaches are far more important than fluid inclusions.

The case, however, is simple, and the evidence perhaps more easily tested by the ancient microscopes than by the cheaper and more popular modern ones, which often dispense with special sub-stage apparatus and mechanical stage. All my petrological readers, with a fair collection of slides, will have among their specimens slices containing liquid carbonic acid. If the subject is new to them, I would suggest their reading Dr. Sorby's and Professor Hartley's remarks on liquid carbonic acid, and having done so to treat these eminent scientists at the outset with respectful scepticism. There is no reason to blindly accept their testimony, because it is open to any petrologist to put much of it to the proof for himself; and it is always safe to follow the example of the late William Froude, F.R.S., who once described himself as a first-rate doubter. Now what we gather from Messrs. Sorby and Hartley is, that in numerous minerals inclusions occur containing two fluids, and that on heating the specimens one fluid often disappears at or about the critical temperature of carbonic acid. In fact, one of the fluids behaves exactly

as carbonic acid should do. I am indebted to Mr. C. W. Priestley, F.C.S., for information as to the latest determinations of the critical temperature of CO_2 and of its pressure at the critical temperature. The critical temperature is 87·75° F., and the pressure 77 atmospheres or 1,155 pounds to the square inch. In the case of the larger cavities Professor Hartley describes the strain on the including crystal as visible in the polariscope. The first experiment, viz. that as to the disappearance, is readily made. We take an inclusion with water and CO_2, and mark the position of the slide on the microscope stage so that we can easily replace it. We warm the slide over the microscope lamp and replace it. The double liquids are gone. The carbonic acid, as gas, is apparently dissolved in the water; but, while we watch, the carbonic acid often returns with a jump. The suddenness with which the carbonic acid often reappears shows that the passage from above to below the critical temperature is very closely defined. It is not a question of the absorption by the water of a little more or less gas. We find further that chemists have experimented largely with various liquids and gases as to critical temperatures, so that the general principle of critical temperatures is well understood.

So far as I can follow the observations of Messrs. Sorby and Hartley on carbonic acid, I find them correct; so I am favourably disposed towards their interpretation of the behaviour of water, and to believe that a liquid alone is competent to dissolve and deposit free salts. This view is indirectly confirmed by the fact that volcanoes discharge hydrochloric acid and chlorine, substances which Dana attributes to the dissociation of marine chlorides which have obtained access to the lava column. If, however, the chlorides of sodium and potassium are dissociated more or less into their elements at volcanic temperatures, say, into hydrogen, chlorine, and soda or potash, and if these substances are then individually dispersed throughout the liquid lava, it would require a miracle for them all to come together again, to be dissolved by water as chlorides, and then deposited as solid crystals in the various minerals which occasionally contain them. It would require a miracle even were the substances retained in the lava, but, according to Dana, volcanoes get rid of both the gases concerned, both as hydrochloric acid and separately as hydrogen and as chlorine.

If, however, anyone can prove the existence of chlorides which have been deposited above the critical temperature of water, we, with all adverse theories, must bow to the fact and accept the miracle. But, when we examine General McMahon's facts, we find them all in favour of the orthodox doctrine. Upon the beryl, containing gas, and fluid inclusions with deposited crystals (species not mentioned), we find crystallised the minerals quartz and muscovite, both of which minerals occur in schists and other non-igneous rocks. Although the dry-fusion temperatures of quartz and muscovite are high, their wet crystallising temperatures may be quite low. Indeed, they must sometimes be so or they would not occur where they do. Fouqué and Lévy mention the crystallisation of quartz at

a temperature of 200° C. Being, however, an undoubted crock, I am extremely disinclined to come between the geological pots and the chemical kettles; and I need only say that my sympathies are with the chemical kettles, because they seem to me to account for all the phenomena which I have observed with my antiquated microscopes.

It has always been a very great perplexity to me that, whereas I have ever relied on the evidence of the critical temperatures, the fluid inclusions, and the deposited chlorides, the great geological authorities, to whom, as captain of a golf club, I bow with genuine humility, scarcely ever refer to or notice these things; and, in consequence, I am in eternal uncertainty. The question always arises, have the geologists disproved and rejected the physical evidence, or do they only ignore it?

Not very long ago two eminent men disputed over the relative fusion temperatures of granite and basalt; but surely the question really is as to the relative crystallising temperatures of these rocks; and, as we know for a fact that basalt can be artificially produced by dry fusion without the intervention of water, and as we also know that granite almost invariably contains water in one or more of its minerals, the dry-fusion temperatures of the two rocks become a mere academic question. Is this not so?

The main wrangle is as to what becomes of the water-vapour above the critical temperature. Well, being a gas it may well be dissolved in the liquid magma, and there it may stop until the lowering of the temperature allows it to resume its liquid state, when it will begin to dissolve the minerals instead of being itself dissolved; but, seeing the rarity of chlorides as rock-forming minerals, it seems improbable that there would be much chlorine or hydrogen in the magma at the cooling stages to enter into combination with the metals, especially as we know for a fact, as has been already noticed, that both those gases are got rid of by volcanoes. The suggestion of Dana that the volcanic hydrogen arises from the dissociation of water is rather negatived by the fact that, while volumes of steam are emitted by volcanoes, hydrogen only occurs in small quantity, and is therefore more likely to be due to the dissociation first of the chlorides and then of the hydrochloric acid, H Cl. Were the water itself dissociated, we might expect volcanic flames on a magnificent scale if the hydrogen recombined in the atmosphere, or constant explosions if the hydrogen recombined in the lava column. As a matter of fact, volcanoes often emit steam very quietly.

Petrologists are much more interested in the proportions of potash, soda, and lime in a felspar, and the consequent angle of extinction of the crystal, than in its crystallising temperature. Yet the crystallising temperatures of the same felspar often vary exceedingly. For instance, General McMahon in his address spoke of the fusing temperature of albite as 1,172° C. Subsequently, when I read my paper, I exhibited a lantern slide showing secondary albite in one of the Devonshire green-schists, which albite contains

water inclusions and chlorite, and is associated with other hydrous minerals. Then, as to quartz: in a slightly altered Devonshire diabase we find, besides chlorite in abundance, secondary quartz-granules which contain fluid inclusions and deposited crystals. No one would attribute much heat to these rocks at the time of alteration; and, as for the diabase, its accompanying Devonian slates do not even reach the dignity of phyllites. Then, on Dartmoor we find felspar, quartz, and tourmaline crystallising at temperatures too low to produce a granitic structure. Although the rule there, is, that the felspar crystallises before the quartz and greenish tourmaline, I have detected one case in which, after the breaking down and partial solution of a felspar by quartz-liquor containing tourmaline-belonites, the felspar repaired damages at the cost of the quartz, and enclosed some of the belonites. This might possibly be explained by the process of cooling being checked, and by a slight reheating first dissolving the felspar and then permitting the recrystallisation of that mineral. But felspar, quartz, and tourmaline were clearly in this case crystallising in the wet way. Dry-fusion temperatures would not assist us in the least; indeed, they could only mislead.

With regard to the permeability of rocks, although, as we have seen, many minerals in mass will resist the pressure of a gas at 1,155 pounds to the square inch for countless ages, and in the thinnest section for an indefinite time, the same minerals are liable to minute and successive fractures; so that a series of water inclusions may traverse a plane of water and carbonic acid inclusions. Although the fluids were originally introduced through planes of fracture, the mineral may be so completely restored that no evidence may remain of the original fissures. In one specimen water inclusions, carbonic acid inclusions, and inclusions with deposited crystals occur near together. It is obvious on inspection that the carbonic acid inclusions are later than the crystal, and that the water inclusions are later again. The relative age of the inclusions with deposited crystals is not apparently indicated. The great charm of the physical theory of granite is that it affords possible solutions for many enigmas, such, for instance, as that of augite-granite, where we find a true high-temperature mineral associated with those of low temperature.

Just at present tourmaline is exercising the minds of petrologists. Nearly forty years ago I took some lessons in mineralogy from Mr. Tennant in the Strand, and I learned that tourmaline had no cleavage, but only a pseudo-cleavage. In after years the absence of tourmaline proved to be the great test of the non-Dartmoor origin of the blocks trawled in the English Channel. Later still I bought a Dartmoor farm, where I can never step outside the door without trampling under foot the tourmaline 'waterstones,' or river stones, which pave the garden path. Many years ago Professor Bonney was good enough to give me his paper on Luxullianite, wherein he derives tourmaline from mica and felspar. I hunted Dartmoor for some years in vain for any evidence that the Dartmoor

tourmaline was derived directly from either of those minerals, and came to the conclusion that Cornish tourmaline must be quite different from Devonshire tourmaline. In trying to work out Mr. Jukes-Browne's sands I found it absolutely necessary to come to some conclusion as to the mica-derivation theory, and asked Mr. Jukes-Browne to go through my slides with me, as my idea was that the mica-derivation was not in evidence on Dartmoor, whatever it might be elsewhere.[1] To my great amusement and delight I have since read Mr. Scrivenor's paper, wherein he derives the Cligga Head brown tourmalines entirely from mica; so once more the luckless crock gets among the pots. It is really a most interesting question. As tourmaline is an aluminous mineral of which boracic acid is an essential constituent, there seems no reason why, with the advent of boracic acid, tourmaline should not be constructed out of any mineral that will supply the other constituents, such as mica, felspar, slate, or clay. But as tourmaline occurs on a large scale as massive schorl-rock, and as in Devon and Cornwall mica occurs comparatively sparingly as scattered and isolated crystals, and, further, as the crystals of tourmaline are often large and those of mica always small, the amount and size of the mica seem unequal to the task of supplying the bulk of the tourmaline, at any rate as it occurs in Devonshire.

For all practical purposes Devonshire tourmaline occurs as three distinct minerals, viz., idiomorphic with the characteristic transverse pseudo-cleavage, in fan-like bundles, and in needles and rods. The characteristic microscopic idiomorphic crystals are apt to show a very marked longitudinal cleavage, which is entirely contrary to 'Cocker.' A longitudinal splinter of tourmaline might be like a flake of mica, but here the vertical *versus* the horizontal extinction would distinguish the two. A transverse splinter of tourmaline would appear to extinguish horizontally, but would differ from mica in the pseudo-cleavage not being absolutely straight. The passage of mica into tourmaline would be an interesting process to trace, as the horizontal extinction would have to change into a vertical extinction.

In his recent paper Mr. Scrivenor has the following passages, viz.:—

(1) "In discussing the origin of the brown tourmaline in Luxullianite, Professor Bonney suggested that that mineral may have been derived from the biotite of the granite; . . . .

(2) "The inferences which I have drawn from the study of these slides is that all the brown tourmaline has been formed from the biotite; . . . .

(3) "Professor Bonney suggested that the blue tourmaline in Luxullianite has been derived from the orthoclase; . . . ."

In my own slide, besides the innumerable greenish acicular crystals, there is one compact crystal, of which one half is light cobalt blue and the other half light brown. It is absolutely characteristic in its transverse pseudo-cleavage, and I would

[1] Derivation from felspar I have since then occasionally noticed; but my slides do not seem to contain an indisputable case of derivation from mica.

willingly stake my reputation as a golfer that this crystal has not the most distant connection with mica. So far as I have been able to judge from the few sections I have seen, the Cornish granites differ from the Dartmoor granites. In Cornwall there seem to be more pressure and fewer chlorides in the main granites. I have noticed bent mica, which is a very significant clue. My Cornish elvan-slides, too, are not so simple as those from Dartmoor; there is more evidence of re-solution. Thus it is quite likely that a good many things occurred to the Cornish granites which did not happen to the more simple and less metalliferous Devonshire rock, and it may not be safe to judge the one by the other. I gather, for instance, that the schorl-veins in Cornwall are sometimes micaceous. Those on the east of Dartmoor seem never to be so. I have a specimen of tourmaline granite sharply in contact with and invading a micaceous granite, in which the tourmalines in the one and the micas in the other, closely adjacent, are absolutely characteristic, and keep strictly to their own rocks.

As a very rough working hypothesis I would suggest the following explanation of the eastern elvans and non-granitoid felspar-quartz-tourmaline veins. We must assume the previous cooling of the main granite, because both elvans and non-granitoid veins invade it. The elvans have the true granitic structure, the non-granitoid veins have not; so we take the elvans to represent a hotter stage of the intruding minerals. These elvan intrusions, whether in the granite or in intrusions a quarter of an inch wide in the Culm slates, contain characteristic idiomorphic crystals of tourmaline, which have crystallised first; and the veins, both granitic and non-granitoid, usually contain no trace of mica. When we get down to the non-granitoid veins, in which the felspar, tourmaline, and quartz have crystallised in succession, we find the tourmaline often to be the fan-like variety, while occasional compact crystals are not specifically characteristic, as they have no transverse pseudo-cleavage. The crystals here seem by nature gregarious, whereas in the granitic veins they are characteristically solitary. In the non-granitoid veins we have proof that the tourmaline occasionally crystallises after the quartz; in the granitic veins never.

If there is any truth in the doctrine of critical temperatures, there is no shadow of a doubt that the non-granitoid veins crystallised out of liquid, below the critical temperature of water. The highest temperature of the elvan-veins is not so certain, but their quartzes almost invariably prove that the rock had cooled down below the critical temperature of water before they, the last mineral in those rocks, crystallised. We have this apparent anomaly, viz., that in the granitic elvan-veins the tourmaline was the first mineral to crystallise, whereas in the non-granitoid veins the tourmaline occasionally crystallises after some of the quartz. But these two tourmalines differ so much in character that no one would guess they were the same mineral unless credibly so informed. Between these extremes of tourmalines there are many intermediate stages.

According to the evidence all these tourmalines crystallised *de novo* out of a magma or liquor derived from the solution of the older granite by fluids charged with boron and possibly fluorine, though fluorine is not much in evidence on the eastern side of Dartmoor, which may indeed account for the greater simplicity of the rock. This solution of the rock and recrystallisation of its minerals was suggested by De la Beche, but in my ignorance of that fact it was forced upon me independently.[1]

The narrow granitic intrusions in the Culm grits afford excellent opportunities for observing the effect of the invading liquor on the two sides of the fissure, and we may see that the aluminous interstices between the sedimentary quartz-granules are sometimes tourmalinised and the quartzes occasionally dissolved; but, for some not obvious reason, the fluid inclusions in my slides stop short at the granite. If tourmaline were a hydrous mineral this might be expected. Is it possible that the water is taken up by hydrous iron-oxide? This tourmalinisation of the alumina of the grits affords the key to a large group of schorlaceous and altered grits, and shows us how tourmaline may either be crystallised out of a liquor containing all the needful constituents or in clays or felspars which supply the alumina *in sitû*. Tourmaline, we see, is not only an extremely variable mineral in colour, form, composition, and mode of aggregation, but is also a mineral formed under very variable conditions of heat and, possibly, pressure. If thoroughly worked out, each variety of tourmaline would probably not only explain itself but also the minerals with which it is associated.

We have heard much lately from Professor Frankland,[2] Mr. Wells,[3] and others, of the effeteness of our old universities, and of Trinity College, Cambridge, in particular. I fear the charge is true. They have not elucidated tourmaline. Yet there have been among their graduates painstaking students, such as Bonney, Hughes, Teall, Tawney, Harker, Hill, Marr, Sollas, Jukes-Browne, and many others. Trinity College is scarcely responsible for myself, because, although I presented myself for examination more than forty years ago, with a more than average schoolboy knowledge of the works of Page, Yarrell, and Westwood, on geology, ornithology, and entomology, and in the way of mechanics had made more than one steam engine, the College earned my lifelong gratitude by 'plucking' me in classics and giving me a much needed lesson in accuracy. I would not exchange that 'pluck' for a doctor's degree; and very thankful I am too that pass degrees in science were not then obtainable.

Pace Messrs. Frankland and Wells, I admit to being one of those wretched beings who much prefer the golf-links to the laboratory; and, indeed, nearly all my attempts at natural history (which pursuit has little in common with the modern commercial and remunerative idea of science) have been made sandwiched with shooting, yachting, farming, and even golfing. If, indeed, a new era has now arisen,

[1] Geol. Rep. on Devon and Corwall, p. 387.
[2] Rep. Brit. Assoc., 1900, p. 593 et seq.
[3] "Anticipations," p. 368.

with improved universities, and improved students with keener perceptions of Nature's minute differences, the old stagers will no doubt welcome them gladly. The British Association meets at Cambridge in 1904, with a Trinity College golfer as President, an ex-captain of the "Royal and Ancient," so here is a chance for the new learning, to elucidate tourmaline and shame the effete.

Personally this granite problem has worried me beyond all reason. For some years I absented myself from the meetings of the British Association and Geological Society, determining not to go to the former until I could attend as an outsider and accept in silence any view whatsoever, and not to go to the latter at all. In 1900 I thought I had attained this state of geological grace, and went to Bradford, where I looked forward to hearing an interesting volcanic debate in luxurious indifference. Now it so happened that when the petrological papers came on, the President and most of the Vice-Presidents had to attend the Committee of Recommendations, while the Vice-President in the chair happened to be a distinguished President of the Geologists Association, to which society the Torquay naturalists had been privileged to show a little attention. No doubt by way of a very pretty compliment to the Torquay Society, and as I happened to be one of the oldest members of committee present, I was requested to take the chair on the spur of the moment, and even after one of the papers had already been read, with instructions to foster a good discussion for a distinguished foreign petrologist. That, with the tact of the Recorder, was easily managed. I was, however, in an extraordinarily false position, as I knew absolutely nothing of the special points under discussion, but I noticed that the old physical theory of granite was ignored by everyone. By way of returning the compliment I submitted a little paper at Belfast which I intended to confirm and elucidate the doctrine I supposed to be orthodox; and lastly, I wrote my short paper on vein-quartz to the Magazine with the view of indicating to students a fruitful subject of enquiry on strictly orthodox lines. I want it to be distinctly understood that I am not writing the present paper as an ex-chairman of Section C and a smatterer in petrology, attempting to teach my betters; but that I am writing as an outside observer, a unit in the crowd of uneducated Englishmen styled by Mr. Wells the "Grey" and the "Abyss," a member of that university and college which modern scientists affect to despise, a naturalist "by grace of the dredge," that abomination of Huxley, and last, but not least, the captain of a golf club. As such I would, in the spirit of friendly expostulation, point out to petrologists how desperately they are puzzling the average Englishman.

Let us face the matter squarely. In the first half of the last century De la Beche expounded the problem of the Western granites macroscopically, with almost unerring precision and prophetic insight. In the early years of the second half of the century Dr. Sorby created the subject of micropetrology with his epoch-making researches on fluid inclusions in their various aspects. His paper of 1858 was an astounding one, but surely one must not blame it if not final and

exhaustive! Dr. Sorby attempted to deduce the weight of once superincumbent strata from the uniformity of the fluid inclusions. It was, however, soon noticed that fluid inclusions are often not uniform. Petrologists at once ran off with the idea that Dr. Sorby's theory had collapsed. Dr. Sorby, however, accepting the teaching of the variable inclusions, pointed out that variable inclusions indicated varying conditions during crystallisation, a fact infinitely more important than the deduction that uniform fluid inclusions might supply a tape measure for measuring the thickness of strata. If we are to credit chemists and physicists, Dr. Sorby is correct in his premisses, and these premisses go to prove that at any rate the final consolidation of most granites was at a temperature below the critical temperature of water; and this critical temperature is as important a mark for the petrologist on the physical thermometer as that of blood heat is to the doctor in his clinical thermometer. Now what would the world say if, knowing as the world does the value of the clinical thermometer, the whole medical profession were to discard it without so much as discussion? Yet this is precisely what the petrological profession has done with its own physical thermometer. And it has done it in the most authoritative way. For many years past petrologists have been quietly treating granite as a high-temperature rock. They have even tacitly accepted Lord Kelvin's theory that granite was the rock primæval, whose minerals crystallised out of and gravitated through a basalt lava. They now accept without demur the doctrine that quartzes, containing both gases and fluids with deposited crystals, can have crystallised at high volcanic temperatures. Well, be it so, but they must not expect golfers and the rest of the uneducated public to follow them, simply because the geological doctrines are self-destructive. Otherwise the said public would have no right to form an independent opinion.

With regard to the origin of plutonic rocks, what we want done is to satisfy both chemists and geologists. For instance, the geologists say that crystals are permeable. The chemists declare that at any rate many crystals will withstand gas pressure of 1,155 pounds to the square inch for geological epochs. I have one set of carbonic acid inclusions which have been imprisoned since Devonian times, yet they will in a thin section undertake their 1,155 lbs. pressure as often as desired. The geologists say that crystals of chlorides can be deposited by water or water-vapour at a temperature approaching 1,200° C. The chemists say "Tush!" or think so.

Here is an important fact. Professor Hartley tells us that when carbonic acid inclusions are present, it is easy to ascertain the temperature of crystallisation of the enclosing mineral.[1] He observes incidentally that such inclusions occur in tourmaline,[2] but as tourmaline is not in the line of his enquiry he omits to state the crystallising temperature of tourmaline; yet that is one of the geological desiderata.

[1] Rep. Brit. Assoc., 1877, p. 236.
[2] Loc. cit., p. 233.

The reason I am anxious to press this question of critical temperatures on geologists is, that I feel sure that the majority do not realise the value or perhaps even the existence of the chemical evidence. Professor Hartley has pointed out that the very variation from the true critical temperature of CO_2 observed in a microscopic inclusion may suffice to indicate the foreign substance mixed with the CO_2, such as nitrogen or hydrochloric acid.[1] It is clearly of great importance if the mere magnifying microscope can tell us the gases, fluids, and solids caught up by a crystal, and the temperature of crystallisation. But petrologists obviously either doubt the value of the evidence or are ignorant of it, for students have ere now been rebuked in the most serious and public manner, not for misapplication of the evidence, but for treating it as worthy of credit, while their teachers treat it as though non-existent. I would not ask petrologists to look to this matter if I were able to do so for them. Friends have wished me to make the attempt, but the idea is too ridiculously absurd. The subject involves a profound knowledge of both chemical physics and optical petrology, and I have neither, nor the power to acquire it. When I go into a golf club I have no occasion to ask any individual member how he plays. The club decides that point for him. I look at the list of handicaps, and see at once whether he is an honour man or a poll man. The universities give men their intellectual handicaps, and in the case of diligent workers the university decision is rarely wrong. My own university handicap was one which Huxley would have deemed scarcely fit even for a bishop, as he allowed even bishops first-class polls. But even indifferent golf-players are allowed to enter competitions, which they do with the more than acquiescence of their superiors, who give them points, *alias* assistance. Since writing this paper I have been impressed with the analogy between the competitions of science and golf. I had to play in a final competition for medallists for a £5 prize, so secured a better player to play me a match and score for me. As a match between ourselves I was successful, with an erratic round including nine fours; but my whole round, or theory, irretrievably broke down at one hole, which cost me thirteen strokes, instead of the orthodox five. Composite science is like medal play at golf. Erratic brilliance is useless; one fatal flaw in either round or theory is as bad as general incompetence. Now the problem of the plutonic rocks and minerals may be compared to a golf course with many and varied holes. We have physics, optics, chemistry, mineralogy, stratigraphy, and general geology. When our cards are examined at the close of the competition, it will be ascertained whether each difficulty has been individually surmounted. If we pick up our ball at either hole, or are guilty of any breach of the laws of golf, we are fatally disqualified, and notwithstanding phenomenal brilliance at our favourite holes, our medal round, our theory, is of less value than

[1] "On Variation in the Critical Point of Carbon Dioxide in Minerals," etc.: Journal Chemical Society, 1876. Reprint, p. 12.

the card on which it is scored, as that may serve to light a cigarette. Perhaps the chief difference between golfers and scientists is that golfers always know when they are 'bunkered,' whereas scientists apparently are often unconscious of the fact, and think nothing of teeing their ball in a hazard. A hazard in plain English is a difficulty, which, according to the laws of golf, if encountered must be surmounted, and not evaded. Evasion, if detected, involves disqualification; but gentlemen do not evade.

With respect to the general question of the crystallisation of rocks we have this curious paradox, viz., that after a rock had consolidated, and already cooled considerably, at a dry heat, the mere advent of water would liquefy it. This, besides being in evidence, follows from the fact that so many minerals which crystallise at high temperatures in the dry way crystallise at low ones in the wet way. Many of the old geologists took the possibility of the access of water as granted, but subsequently this was stoutly denied. However, after the blow up of Krakatoa and of the hot-lake district in New Zealand, the evidence seems to favour the ancients. Considering that many regions are jointed and fissured in all directions, and that earthquakes make fresh fissures, and seeing that a column of water at a depth of 3,000 fathoms weighs about 600 atmospheres, or 9,000 pounds to the square inch, the access of water to highly heated though consolidated rocks seems more probable than otherwise. But if such access ever occurs there must be liquefaction, reconstruction, recrystallisation, and metamorphosis in almost every variety; and the creation of new minerals too, for the sea-water does not come empty-handed, but charged with the highly important rock-forming minerals soda, potash, magnesia, and lime. But when we come to chemistry at a pressure of 600 atmospheres and upward, we cannot safely afford to ignore the chemists and the physicists, any more than physicists can afford to formulate a theory of granite in defiance of petrologists, as was actually done a few years ago.

I would desire, very respectfully, to point out the great perplexity caused to students by what may be termed incidental petrology. The whole object of the present paper is to discuss General McMahon's incidental remark—"the beryl is crowded with liquid and gas cavities, the former containing movable bubbles and deposited crystals as well as water" (Rep. Brit. Assoc., 1902, p. 590).

So far as I am aware, the only record of the occurrence of magnetite in cubes in Great Britain is Professor Bonney's quite incidental statement—"Magnetite, very abundant in minute grains, which, however, evidently are often cubes or octahedra" (Proc. Roy. Soc., 1892, p. 399). As has been already pointed out, the extremely important question of the derivation of tourmaline was discussed, also quite incidentally, in a mineralogical paper dealing with Luxullianite.

Lord Kelvin's theory of granite and basalt, again, was completely incidental to his "Age of the earth." It is, no doubt, incompatible with all previous doctrine on the subject, but with the general

public, on this as on every other subject, Lord Kelvin's judgment is law. Weighed in the public scales, Lord Kelvin will pull down every geologist, past, present, and to come.

I have not the smallest ambition, in the matter of granite or in any other, to convert geologists to my own way of thinking. I only seek information in order that my own way of thinking may be corrected if erroneous.

IV.—Note on a Section of Great Oolite Beds at Condicote, near Stow-on-the-Wold.

By L. Richardson, F.G.S.

One mile north-west by west of Condicote in the North Cotteswolds, a village distant about $2\frac{3}{4}$ miles in the same direction from Stow-on-the-Wold, there is a quarry in which the following beds are exposed :—

Section near Condicote.	ft.	in.
1. Dark-coloured soil	1	4
2. Yellowish, clayey marl, with a little rubble of whitish and slightly oolitic limestone in places near the top ; *Rhynchonella concinna*, *Terebratula maxillata*, *Ataphrus Labadyei*, *Cerithium* (smooth species), *Nerinæa* cf. *Dufrenoyi*, D'Arch., *N.* cf. *Voltzi*, Desl., *Chemnitzia* cf. *hamptonensis*, M. & L., *Isastræa limitata* with specimens of *Ostrea* adhering to it, *Microsolena* (probably *M. porosa*, Lam.), *Modiola Lonsdalei*, *Trigonia pullus*, *Ostrea Sowerbyi*	1	11
3. Grey, somewhat arenaceous, flaggy limestone ; *Ostrea* aff. *acuminata* ...	6	0

Reference to the Geological Survey map, Sheet 44, will show the exact position of the quarry : to the south of the junction of the road from Condicote to Scarborough with that leaving the main road opposite the lane which comes past Rook Pool Barn (now Kinetonhill Farm) and Rook Pool. The area in which the quarry is situated is thus indicated as being composed of Inferior Oolite rocks. The fauna contained in Bed 2, and especially the *Rhynchonella* and *Terebratula*, clearly shows that this is an error. I am indebted to Mr. W. H. Hudleston, F.R.S., for kindly examining the Gasteropods. Their state of preservation only allowed of their being identified approximately, but, as Mr. Hudleston observed, "they certainly wear a Bathonian facies rather than that associated with the Inferior Oolite."[1] Mr. R. F. Tomes, F.G.S., kindly determined the corals. The specimen of *Trigonia* obtained agrees with that figured by Lycett in his "Monograph of the British Fossil *Trigoniæ*," pl. xxxiv, fig. 9, as *T. pullus*; but not with the *T. pullus* of Sowerby.

There is no doubt whatever as to the age of the deposit, and the section is useful in that it affords an opportunity for investigating the lithic and faunal characters of the Great Oolite strata at the most northerly point at which they are preserved in the Cotteswold Hills.

[1] In litt. July 7th, 1903.

V.—Further Remarks upon the Carboniferous Arachnid *Anthracosiro*, with the description of a second species of the genus.

By R. I. Pocock, F.Z.S., of the British Museum (Natural History).

In the Geological Magazine for June of this year I proposed the new specific and generic names *Anthracosiro woodwardi* for a Carboniferous Arachnid represented in the British Museum by a single specimen (No. 1551) from Coseley, near Dudley, that formerly belonged to the collection of Mr. Henry Johnson. A further communication from Dr. Frič, of Prague, drew my attention to three additional specimens, with the same history, numbered 1554, 1555, and 1556, and ticketed *Eophrynus*, sp. nov. No. 1555 is the under-side of a scorpion, without the tail; the others are referable to the genus *Anthracosiro*.

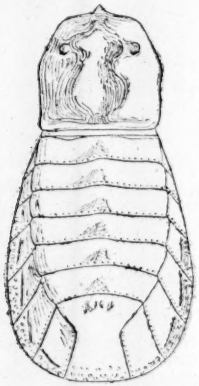
No. 1554 appears to belong to the same species as the type of *Anthracosiro woodwardi*. Unfortunately the prosoma is so crushed that no details of its structure can be deciphered, beyond a confusedly radial arrangement of certain of its component parts indicating the disposition of the coxæ, and a broad central longitudinal ridge representing presumably the median area of the carapace. The position and length of the legs is also shown; but nothing new concerning their structure can be made out. The rest of the fossil consists of the terga of the opisthosoma, the entire ventral surface being wanting, except apparently the inturned portion of the eighth, which exhibits very clearly the subcircular anal plate (tergum of the tenth segment), surrounded by the narrow and annuliform united tergal and sternal elements of the ninth.[1]

As in *A. woodwardi*, the external portions of the laminæ of the third, fourth, fifth, and sixth terga are defined by a groove and upturned; and no joint is visible between the laminæ of the eighth and the median area of the tergum from which they arise. Except that the hinder borders of the posterior terga are rather more recurved than in the type of *A. woodwardi*, there is very little difference between the two fossils; and, without a series of specimens to test the constancy of this feature, it would be rash to attach a specific value to it.[2]

[1] I am unable to satisfy myself absolutely whether the two halves of the nodule exhibit the dorsal side of the terga and the impression of the same or the ventral surface of these plates and their impression; but I incline to the latter opinion on account of the distinctness of the anal sclerite and the lesser definition in detail presented by the half of the fossil showing what is either the dorsal surface of the terga or the impression of their under-side. So far as the structure of the plates is concerned, a definite decision on this point is a matter of no great moment; but the view here adopted carries the conclusion that the sternal elements have been entirely removed; whereas, according to the other hypothesis, the sterna remain in all probability buried in the stone.

[2] In the description of *A. woodwardi* I stated that a pair of tubercles is present upon the terga. This is an error. The tubercles appear upon the half of the fossil which is the impression of the dorsal surface. They therefore represent pits, not tubercles; and are doubtless to be referred to the paired muscular impressions characteristic of the terga of many Arachnida.

The other specimen, No. 1556, is the more important and instructive of the two. It is the fossil of a much smaller animal. One half of the nodule of clay-ironstone in which it is imbedded shows the dorsal surface; the other the impression of the latter. The chief feature of interest is the excellent state of preservation of the carapace. In the type of *A. woodwardi* this plate is crushed, showing nothing but the shape of its outline. Concerning its probable structure, I remarked that its crushed condition suggests that its median area was axially elevated, as in *Eophrynus prestvicii* and *Kreischeria wiedei*, and that it was justifiable to conclude that it was constructed essentially as in these genera. The fossil under notice proves the first suggestion to be true; the second false. The carapace is strongly arched, both longitudinally and transversely. From its highest point, which lies in advance of the middle, it slopes downwards, both anteriorly and laterally, and a pair of obtuse ridges, diverging somewhat abruptly from the middle line, then curving inwards and downwards, extends backwards almost to the posterior border of the carapace. The area between these ridges is widely and somewhat deeply excavated; externally to them the surface slopes downwards to the lateral margin. Anteriorly each ridge forms a smaller curve, also with its convexity outwards; and nearly midway between this and the lateral border there is a very distinct ocular tubercle. The outline of the carapace is almost exactly the same as that figured for *A. woodwardi*. There was possibly a small median process projecting forwards from the anterior border, and the posterior portion presents a short horizontal area as in the last-named form.



Anthracosiro fritschii, sp.n., dorsal surface. × 7½.

The tergal plates of the opisthosoma agree in the main with those of *A. woodwardi*, with the exception that the first is relatively much shorter. It appears upon the impression as a short sclerite, not half the length of the succeeding plate; but upon the fossil itself it is invisible, so that the opisthosoma appears to be supplied with but seven tergal plates on the upper side. The median line

of these plates is elevated in the form of a triangular crest; that of the eighth is tubercular; and since the impression exhibits a multitude of close-set punctures upon the terga, it may be inferred that these plates were finely granular. This granulation is not apparent in *A. woodwardi*; but, as in that species, there is a row of coarser granules along the posterior border of the terga and of their laminæ, at least in the hinder half of the body. There is also a very distinct joint between the lateral laminæ of the eighth tergal plate and the area from which they arise. These joints are not visible in *A. woodwardi*. Towards the lateral border of the laminæ of the fifth, sixth, seventh, and eighth terga there is a distinct longitudinal groove; the area lying externally to this is bent upwards so that the dorsal surface of the opisthosoma is posteriorly scoop-shaped. The sculpturing of this area of the laminæ is more coarsely tubercular than the rest of the terga.

Total length 6·5 mm.; width of opisthosoma about 3 mm., length of prosoma 2 mm.

Since there is no reason to suppose that the differences between this specimen and the type of *A. woodwardi*, apart from the great discrepancy in size, can be attributed to age, there is no choice but to regard the two as representatives of distinct species. I propose to name this new form *Anthracosiro fritschii*, after Dr. A. Frič of Prague.

The characters of the two may be tabulated as follows:—

a. Terga of opisthosoma not granular throughout; the first large, more than half the length of the second, which has its anterior border mesially emarginate; joints between the proximal extremity of the lateral laminæ and the median area of the eighth tergal plate not apparent. Length from 17 to 21 mm. ... ... *woodwardi*, Poc.

b. Terga of opisthosoma finely and closely granular; the first very short, much less than half the length of the second, of which the anterior border is straight from side to side; joints between the laminæ and the median area of the terga of the eighth segment present. Length about 6·5 mm. *fritschii*, sp.n.

The two additional specimens of *Anthracosiro*, especially the one last described, make it possible to give a far completer diagnosis of the genus than could be based upon the single example of *A. woodwardi*. Pending the discovery of specimens showing fully the structure of the appendages and the ventral surface of the body, the diagnosis may run as follows:—Carapace vaulted, with a wide depression in the middle of its dorsal surface and a very short posterior transverse area. A pair of widely separated ocular tubercles in its anterior half. Upper side of opisthosoma presenting eight tergal plates, which are without tubercles, but are marked with a pair of muscular impressions; the first much shorter than the second; their anterior and posterior borders transverse, subparallel, scarcely or only slightly recurved at the posterior end of the body; laminæ rhomboidal, small at the anterior end of the body,

gradually increasing in size posteriorly, the margins forming a continuous curve, those arising from the terga between and including the second and seventh directed obliquely backwards, their transverse axes inclined at an obtuse angle to those of the terga to which they are attached. Ninth segment annular, encircling the subcircular tergum of the tenth, which forms the anal valve.

In the above quoted paper describing *Anthracosiro woodwardi*, it was suggested that this genus should be classified in the same section as *Eophrynus* and *Kreischeria*. The discovery of the structure of the carapace as seen in *A. fritschii* shows this view to be untenable, and establishes the right of *Anthracosiro* to stand in a distinct family, if family rank be assigned, as has been done, to the analogous differences between *Anthracomartus* and *Eophrynus*. In the structure of the carapace *Anthracosiro* is more like *Anthracomartus* than *Eophrynus*, while in the structure of the opisthosoma it differs markedly from both.

The characters of the three groups may be tabulated as follows:—

a. Tergal laminæ of opisthosoma directed obliquely backwards, their transverse axes inclined at an obtuse angle to the transverse axes of the terga, which in the posterior half of the body are scarcely, if at all, recurved; carapace vaulted, widely depressed in the middle line above; eyes represented by a pair of widely separated tubercles situated a short distance above the lateral margin ... Anthracosironidæ.

b. Tergal laminæ of opisthosoma, with their transverse axes in all cases in the same line, whether curved or straight, as the transverse axes of the terga; terga in the posterior half of the body becoming gradually more and more recurved towards the anal extremity; eyes, when visible, close to the middle line of the carapace.

a'. Carapace flattish or evenly vaulted, not differentiated by deep grooves into definite elevated areas ... Anthracomartidæ.

b'. Carapace dorsally differentiated into a median lobate axial elevation and a lateral flat segmentally grooved area. Eophrynidæ.

For the characters of the genera referred to the Anthracomartidæ and Eophrynidæ, reference may be made to my paper entitled "*Eophrynus* and Allied Carboniferous Arachnida" in the Geological Magazine for October and November of last year.

VI.—Photography in Geology.

By Henry Woodward, LL.D., F.R.S., F.G.S.

(PLATE XX.)

PHOTOGRAPHY has now become so invaluable an accessory to every branch of science, that it is not surprising to find it has proved indispensable alike to the geologist and the palæontologist. One has but to turn back over the four decades of this Magazine and compare the number and quality of the illustrations, in the earlier with the later years, in order to realize the great advances

that have been made by the application of photography both to *process-plates* and to illustrations in the text (especially in the last quarter of a century), which has so enriched and enhanced the value and interest of this and other scientific journals. That good half-tone process-blocks can be made from photographs of any geological subject taken in the field, is now well established; nevertheless, two points are absolutely essential to their success: (1) the photograph must be particularly clear and well-defined in its details; (2) the block, however good, may easily be rendered worthless by bad or careless printing; moreover, it must be reproduced upon paper with a finely finished surface, although it need not necessarily be the highly glazed kind (heavily loaded with kaolin) now so much in vogue for the illustrated Monthlies.

The project of forming a large permanent public collection of photographs, illustrating as far as possible the most important features of geological interest in the United Kingdom, was initiated by Mr. O. W. Jeffs in 1888, who read a paper upon the subject at the Bath Meeting of the British Association in that year; and in the year following, a Committee[1] was appointed and Mr. Jeffs undertook the management of the work, which he carried on for seven years with indefatigable zeal and care, only relinquishing it when the size of the collection began to exceed the capabilities of private control and the possibility of one person being able to devote the requisite time and attention to its custody. Up to the year 1895 twelve hundred photographs had been obtained, and it was deemed advisable that the collection should be placed in the Library of the Museum of Practical Geology, Jermyn-street, where it has since remained, and is available for reference to all those who take a real interest in or desire to make a proper use of it.

It is no easy task to arrange and catalogue such a collection properly, and this has now been and is being done with the sanction of the Director of the Geological Survey, under the careful supervision of the Committee's indefatigable Secretary, Professor W. W. Watts, M.A., Sec. Geol. Soc., and has already proved of the very greatest use to geologists, whilst its ample store of beautiful illustrations are being constantly added to, and also drawn upon for purposes of illustrating works on descriptive geology and physiography and for various textbooks.

The collection is moreover a permanent record of all the most important features in the geology and scenery of our Islands, as seen to-day; but very soon some important modification may have taken place, and by to-morrow a storm, a landslip, or the action of the sea may have changed the face of Nature at the spot depicted, and the now carefully preserved picture may be the only record of the interesting scene. Happily, we are not subject to earthquakes or volcanic disturbances in this country, as in Italy, New Zealand, or the West Indies, which might destroy a whole

[1] For an earlier account of the work of the British Association Photographic Committee see articles by Professor W. W. Watts, M.A., Sec. Geol. Soc., in Geol. Mag., 1897, Dec. IV, Vol. IV, pp. 31–37, 62, and 109.

district and bury up its towns; but, nevertheless, our coastline is so extensive, owing to its indented and insular character, that we are particularly exposed to the effect of storms and marine denudation, so that our shores have undergone or are undergoing many changes, some parts, like Sandwich, being deserted by the sea, and others, like Reculvers, Cromer, and Southwold, being eaten away by the waves. Cliff-sections, too, like those of Lyme Regis in Dorsetshire, and even harder rocks, like those of Muckros Head, co. Donegal (see Plate XX), are constantly subject to the destructive action of the sea, and even after a very few years undergo visible change of contour and recede before its erosive attacks. Quarry-sections and railway-cuttings, often of very great geological interest, are generally only to be seen temporarily; the former changing with the progress of the work of extracting the stone, chalk, or ballast, the latter too frequently being grassed over and otherwise rendered obscure by rainwash from the surface. These have to be photographed at once upon the spot, and this is not always easily accomplished. Thanks, however, to a great number of enthusiastic amateurs who have aided the Committee in its work, men like Professor E. J. Garwood, Professor E. W. Reid, Godfrey Bingley, A. K. Coomáraswámy, A. S. Reid, Professor S. H. Reynolds, J. A. Cunningham, W. L. Howie, G. J. Williams, and professional photographers like A. Welch, the British Association series of geological photographs has now attained a well-deserved and recognised importance and value.

Among the various advantages offered by the Photographs Committee as the outcome of their labours are: the supply of (1) sets of geological photographs for use in museums, with appropriate letterpress, both mounted and unmounted; (2) sets of lantern-slides for geological lectures; (3) views for book illustrations, of which many authors have availed themselves even within the last twelve months.

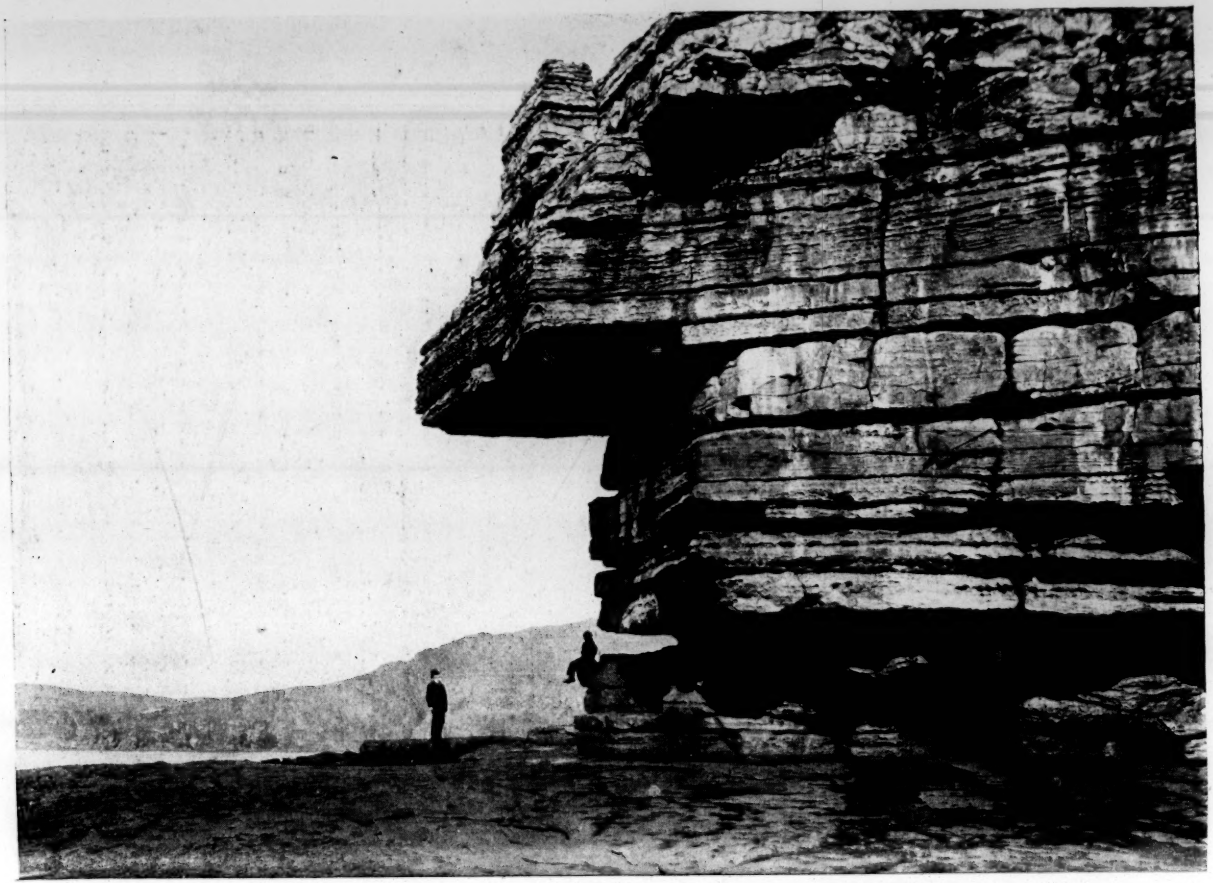
It would be difficult, however, to define the limits of the usefulness of these admirable pictures to the writer, the teacher, the lecturer, the museum curator, the artists, and the public at large.

The second series of geological photographs published by the British Association Committee have just appeared. The set comprises 4 whole plates, 18 half plates, and 4 quarter plates, also a series of 26 lantern-slides.

The photographs are all copyright. Descriptions in pamphlet form accompany the photographs, and with the unmounted prints a set of labelling slips is sent.

The description which accompanies each photograph has been prepared with great care, either by the author of the photograph or by some active member of the Committee, and occasionally small sketches are added in the text, giving (diagrammatically) the geological details to be seen in the photograph.

For example, Professor Grenville A. J. Cole writes of the beautiful photograph taken by Mr. R. Welch (of 49, Lonsdale Street, Belfast), a copy of which forms the subject of Plate XX accompanying this notice:—



Bedding and Jointing in Carboniferous Sandstone: Muckros Head, Co. Donegal, Ireland.

Reproduced by permission of Mr. R. Welch, Belfast.

(p. 12.) "*No.* 1664. *Bedding and Jointing in Carboniferous Sandstone; Muckros Head, Donegal.*

Photographed by R. Welch; 1890.

At Muckros Head, in the west of Co. Donegal, an outlier of Lower Carboniferous sandstone and limestone runs out into the sea. The horizontal bedding and vertical joints control the weathering of the cliff, and ledges of more resisting rock project boldly from the wall. The two vertical series of joints are fairly perpendicular to each other. In certain beds lamination is well exhibited.

GRENVILLE A. J. COLE."

Of the photographs dealing with volcanic subjects may be specially mentioned a fine example of a basalt dyke taken by Mr. R. Welch, (B.A.) 974, and described by Mr. W. B. Wright. The dyke is seen cutting through the chalk on the south side of Cave Hill, Belfast, co. Antrim. The chalk itself is converted into a hard white limestone, in which may be seen well-defined layers of flint. A flow of lava rests upon the eroded surface of the chalk, the latter being covered with a bed of flint gravel, most of the flints in which are stained a deep red colour.

Another fine photograph, also taken by Mr. R. Welch, is (B.A.) 1652, and represents a portion of the columnar basalt of the Giant's Causeway, co. Antrim, described by Professor T. G. Bonney, F.R.S.

(p. 18.) "*No.* 1652. *Columnar Basalt, Giant's Causeway, Antrim.*

Photographed by R. Welch; 1893.

Columnar jointing is rather common in basalt, and that of the Giant's Causeway affords excellent examples. As the structure is due to contraction in cooling the columns are usually six-sided (R. Mallet, Phil. Mag., ser. IV, vol. i, p. 122). Further contraction produces cross joints. These may be frequent, as in this instance, or at rather long intervals, as in the Siebengebirge. Their form varies; it is sometimes a plane; sometimes part of the surface of a large sphere, covering all the end except, perhaps, the angles, as with most of those in this photograph: sometimes an almost hemispherical dome rises in the middle of a flat roof. The curves, as can be seen, do not all point in the same direction. Occasionally spheroids, which may be concentric, form inside a column without external rupture, and are only exposed by weathering. A column in the bottom left hand corner shows a tendency to this structure, which also may be exhibited in the occasional fractures at the corners of the blocks. This is a result of the principle of least-action, but difficulties often arise in applying that to particular instances (Quart. Journ. Geol. Soc., xxxii, 1876, p. 140).

T. G. BONNEY."

There is another volcanic picture, that of the well-known "Scuir of Eigg" (No. 2562), photographed by Mr. Arthur S. Reid, M.A., F.G.S., who also gives a detailed description of the same, and refers the reader to Sir A. Geikie's great work on the Ancient Volcanoes of Great Britain, 1897, vol. ii, pp. 236–248.

A fine example of erosion is seen in the photograph taken by Mr. E. A. Bush, of the Hemlock Stone, Stapleford Hill, Notts, described (p. 10, No. 2879) by Mr. Walcot Gibson, F.G.S. This stone is a column 31 feet in height and 70 feet in girth, and is an excellent illustration of erosion by wind action and atmospheric weathering.

Professor E. J. Garwood contributes a beautiful photograph (No. 624) and description (p. 17) of the intrusive igneous sheet in Carboniferous rocks known as the Whin Sill, High Force, Teesdale. This is a classical waterfall described by Sedgwick in 1823. The

fall is 70 feet high over the Whin Sill, which is here intrusive in the Lower Yoredale Beds.

A photograph by Mr. Godfrey Bingley (No. 1912) representing the upper course of a stream—"High Cup Gill," near Appleby, Westmoreland—is described by Professor E. J. Garwood (on p. 15). It depicts a typical V-shaped valley, joining that of the Eden from the eastern side. The Gill is excavated in the Lower Carboniferous beds against the dip of the strata (down the scarp side), and the old dip-valley, draining down eastward to the Tees, is seen on the right side of the photograph.

Another example of Mr. R. Welch's fine Irish photographs is

(p. 10.) "*No.* 963. *Pot-hole in Basalt, Glenariff, Co. Antrim.*

This is a very typical example of a circular hole in the bed of a stream drilled by means of pebbles swirled round in eddies of the water when the stream carries an ample current. The hard pebbles are probably provided by the Boulder-clay in the neighbourhood of the glen. Such holes are remarkably circular in plan, with their sides well smoothed and polished, while the pebbles become ovoid and very well-rounded. Further down stream there are other very deep pot-holes, and gorges excavated partly by pot-hole action. A scale is given by the vegetation.

W. W. Watts and R. Welch."

At p. 14 Professor James Geikie, Chairman of the Committee, describes (No. 1815) a small photograph, which we could wish was larger, but which will no doubt make an admirable lantern-slide, representing the historical Parallel Roads of Glenroy, looking N.N.E. from the northern slope of Bohuntine Hill, about half a mile south of Achavady, Argyllshire.

"Photographed by W. Lamond Howie; 1896.

The 'Parallel Roads' are narrow terraces or benches, 40 to 50 feet in width, running horizontally and parallel to each other along the mountain slopes. They are not flat, but have an inclination of 12° to 20° or thereabouts. They consist chiefly of angular detritus of local rocks, mostly overgrown with vegetation. Originally considered by Darwin and others to be sea-beaches, they are now generally admitted to mark the successive levels of a glacier-dammed lake. The 'roads' are seen in this view on the east side of the glen, at heights of 1,153, 1,077, and 862 feet respectively, heights which correspond with three cols, one at the head of the main glen, one on a left-hand tributary, Glen Glas Dhoire, and one at the head of Glen Laggan, into which the lowest 'road' passes.

James Geikie and W. Lamond Howie."

Did space and means permit, we should like to present to our readers reproductions of all of these excellent and instructive pictures with their accompanying descriptions, but instead we strongly recommend them to send a guinea to Professor W. W. Watts, M.A., Sec. G.S., Holmwood, Sutton Coldfield (Secretary of the British Association Geological Photographs Committee), who will cause to be sent to them 20 unmounted platinotypes with appropriate letterpress—or, still better, they may engage to send one guinea *annually*. For 30*s*. they will receive 20 mounted platinotype views on cards, and for £1 5*s*. 20 lantern-slides with letterpress may be obtained.

We cannot conceive of a more delightful present to make to a young, or old, geologist than one or both of the above charming series, or 20 *annually* as a birthday or New Year's gift!

NOTICES OF MEMOIRS, ETC.

I.—Cretaceous Cephalopoda from the Hokkaidō. Part I: *Lytoceras*, *Gaudryceras*, and *Tetragonites*. By Hisakatsu Yabe, Geological Institute, Science College, Imperial University, Tōkyō. Journal of the College of Science, Imperial University, Tōkyō, Japan, vol. xviii, Art. 2. pp. 55; 7 plates. 1903 (published 8th June).

THE Hokkaidō forms part of the Japanese empire; it lies to the north of the mainland, and consists chiefly of the island of Yezo or Yesso, having an area about equal to that of Scotland and Wales combined. The occurrence of Cretaceous Ammonites in the island was first mentioned by B. S. Lyman in 1877, and his collection, comprising some fifteen species of Cephalopoda, was briefly described three years later by Naumann. In 1890, in his work on the fauna of the Japanese Cretaceous rocks, Professor Yokohama more fully described the Cretaceous Cephalopoda of the Hokkaidō; but it was not until the island had been geologically surveyed by Professor Jimbō and his assistants that the nature and extent of the Cretaceous deposits there were known.

The Cretaceous formation in the main island of the Hokkaidō rests upon Palæozoic rocks, and is overlain by coal-bearing rocks; it extends in a north-south direction on the west side of the main axis of the island; it is a purely marine deposit, its fauna being very rich in Mollusca, particularly in Cephalopoda. Although the author of the present memoir went to the Hokkaidō mainly for the purpose of ascertaining the relation of the Cretaceous Ammonite-bearing deposits to the coal-bearing series, he made a large collection of Cretaceous fossils and carefully examined the stratigraphy of the Cretaceous rocks. He proposes the following subdivisions, beginning from below :—

I. The lower Ammonite-beds with *Orbitolina*-limestone.
II. The *Trigonia*-sandstone.
  a. Lower *Acanthoceras*-zone or *Trigonia longiloba*-zone.
  b. *Thetis*-zone.
  c. *Pectunculus*-zone.
III. The upper Ammonite-beds.
  a. Upper *Acanthoceras*-zone.
  b. *Scaphites*-beds.
  c. *Pachydiscus*-beds.

According to the author all the beds are quite conformable to each other, the upper ones passing gradually into the coal-bearing series.

Various opinions respecting the age of the Cretaceous rocks of the Hokkaidō have been expressed, but the author reserves the discussion of the nature of the fauna until the end of his memoir.

The whole of this part of the present memoir deals with the description of those Ammonites which were formerly included in

the genus *Lytoceras*, but which are now separated into *Lytoceras*, *Gaudryceras*, and *Tetragonites*. Upon Uhlig's group of *Lytoceras Sacya* A. de Grossouvre founded the genus *Gaudryceras*; from this Kossmat separated two other types which he named *Tetragonites* and *Pseudophyllites*, regarding all three forms as subgenera of *Lytoceras*.

Pseudophyllites, so far as at present known, is represented by only one species, *P. indra*. Naumann recorded from the Hokkaidō a new species allied to *P. indra*, but according to Professor Yokohama the specimen is much too fragmentary for specific determination, and unfortunately the collection made by the author did not include an example of the species.

Lytoceras, s. str., is represented by two species, both of which are new.

Gaudryceras can be divided into two well-marked sections, the one containing *G. Agassizianum* and *G. Marut*, the other being the group of *G. Sacya*. All the species of *Gaudryceras* are very imperfectly known. "This," says the author, "is partly due to the fact that, although they are very common especially in the Upper Cretaceous deposits of the Indo-Pacific region, the specimens usually belong to immature animals, and consequently closely resemble one another, so that the determination is not only very difficult, but often quite impossible. Moreover, the aspect of the shell of this genus is so different in its younger and older stages, that without a large series of specimens for comparison, the larger and smaller forms are often liable to be separated into distinct species." All the *Gaudryceras* from the Hokkaidō belong to the group of *G. Sacya*, which the author subdivides into six subgroups, based mainly upon the character of the full-grown shells; four new species and a number of new varieties are described.

In the genus *Tetragonites*, besides the species described by Jimbō as *Lytoceras glabrum* and recognized by Kossmat as belonging to this genus, the author places Professor Jimbō's *Lytoceras sphæronotum* and *Lyt. crassum*.

Judging from the figures and the detailed observations which the author has been able to make on some of the species, it seems that, like the fossils from the Upper Cretaceous rocks of Southern India, the specimens are exceedingly well-preserved.

We most heartily congratulate the author upon his work, and hope ere long to have the pleasure of seeing a further portion of his memoir. G. C. C.

II.—Report of the State Geologist (George H. Perkins) on the Mineral Industries and Geology of certain areas of Vermont. pp. 191, with 64 plates. Albany, New York, 1902.

THIS volume, for 1901–2, is the third of the series issued by the present State Geologist. It includes biographical sketches of two old Vermont geologists—Zadock Thompson (1796–1856) and Augustus Wing (1808–1876)—and gives a bibliography of the official and other publications relating to the geology of the State. The only mineral products of any economic importance are asbestos

and building and ornamental stones, and the report on the mineral industries extends to only 15 pages. The bulk of the volume is occupied by the following articles :—

"The Granite Area of Barre," by G. I. Finlay.

"The Terranes of Orange County, Vermont," by C. H. Richardson.

"The Geology of Grand Isle," by G. H. Perkins.

"Petrographic Description of the Dikes of Grand Isle," by H. W. Shimer.

III.—Plumasite, an Oligoclase-Corundum Rock near Spanish Peak, California. By A. C. Lawson. Bull. Dep. Geol. Univ. California, 1903, vol. iii, pp. 219–229.

IN 1898 Morozewicz proved experimentally that corundum is capable of crystallising from an igneous magma containing an excess of alumina; since then corundum-syenites have been described from India, the Urals, Ontario, and Montana. Previously, corundum had not been recognised as an essential constituent of igneous rocks.

The corundiferous igneous rock now described occurs as a dyke, 15 feet in width, intersecting amphibole-peridotite. It is composed of a coarse allotriomorphic granular aggregate of white oligoclase with embedded crystals (acute rhombohedra) of pale violet-blue corundum, the two minerals being present in the proportion of 84 to 16 respectively. To this new type of rock the name Plumasite, from the locality, Plumas County, is given. The rock of other portions of the same dyke consists only of white felspar without corundum.

IV.—Palacheite. By A. S. Eakle. Bull. Dep. Geol. Univ. California, 1903, vol. iii, pp. 231–236.

THE mineral to which this new name is given occurs abundantly as a recent formation in the old workings of the Redington mercury mine, Knoxville, California. The brick-red crystals are monoclinic, and their chemical composition is expressed by the formula $Fe_2O_3 . 2\,MgO . 4\,SO_3 + 15\,H_2O$. Although stated to be a new mineral, it is not proved to differ essentially from the imperfectly described rubrite.

REVIEWS.

I.—A Great Catalogue of Books on the Natural Sciences.

Catalogue of the Books, Manuscripts, Maps, and Drawings in the British Museum (Natural History). Vol. i, A–D (500 pp.). By Bernard Barham Woodward. 4to. London: printed by order of the Trustees, 1903. Price £1.

WHEN the Departments of Zoology, Geology, Mineralogy, and Botany were housed at Bloomsbury, each had its own small library of working books, but obtained such other works as were required from the great library of the Printed Books Department. When these Departments were removed to Cromwell Road in

1880–1883, it became necessary to form a new library for their requirements, and a special vote was obtained from Parliament for this purpose. The Departmental libraries were retained and added to, while a 'General Library' was formed to receive such books whose subject-matter concerned more than one of the special Departments. By this means much needless duplication was avoided. Accessions are constantly being made by purchase, donation, or exchange, and though there are still some 'desiderata,' it is not too much to say that this collection of works on Natural History is one of the finest and most complete ever brought together. This is especially the case with serial publications and works issued by Academies, in many of which the wrappers have been preserved, that are so important and valuable in these days of contested priority in nomenclature.

In 1881 Mr. B. B. Woodward was transferred from the Printed Books Department to South Kensington, and placed in charge of the new General Library then being formed, while he subsequently had general charge of the cataloguing of all the collections of books in the building. It is to his careful and exact knowledge of books and special knowledge of the requirements of workers in Zoology and Geology, that we owe many of the literary treasures in the British Museum (Natural History). Working at first alone, and in later years with the intelligent assistance of his attendant Mr. Charles Leigh and afterwards of Mr. C. Hadrill, and a clerical assistant, he has catalogued this grand collection of scientific books from a bibliographical standpoint, and the present volume (the first of four) is the fruit of his labours.

Since the whole of the manuscript is almost finished, we may hope in a very few years to have the complete work before us, and when using it daily shall be able to form some slight idea of the thought and labour bestowed upon its production. Constant use both of the MS. and of the proofs for many years, allows the writer to state that it is undoubtedly the most complete and exact catalogue of scientific publications (other than *separata*) ever printed.

Each entry in the catalogue is complete in itself, thus allowing it to be cut up for a card catalogue, a system of course in vogue at the Natural History Museum.

The entries are arranged under the names of the authors, but should no author's name appear, the work is entered under the principal word of the title, preference being given to such as most clearly defines the contents.

Societies and Corporate Bodies are considered to be the authors of their publications, and are entered—(*a*) English, Colonial, and American Societies, with such others as are not local, directly under their proper name; (*b*) all others under the name of the place in which their headquarters are situate.

Official accounts of Surveys and Explorations undertaken by any Government are placed under the name of the country issuing them.

Magazines and Journals of a similar character are entered under the first words of the title, omitting articles.

Maps are entered in the first instance under the name of the country charted.

Cross-references are given freely in all cases where they will facilitate research.

Titles in Russian, Servian, Japanese, and other Eastern languages have been transliterated and translated, help in this direction having been freely given by Professor R. K. Douglas, members of the Japanese Embassy, and members of the staff of the Printed Books Department at Bloomsbury.

Mr. Woodward also acknowledges assistance received from Dr. Henry Woodward, Dr. Arthur Smith Woodward, Mr. L. Fletcher, Mr. J. Britten, Professor F. J. Bell, Mr. G. C. Crick, Mr. G. A. Boulenger, Dr. F. A. Bather, and others.

Referring to the exactitude with which the work has been done, let us turn to BERENDT (G. C.). The first entry gives his name in full and his birth and death dates, and lists a tract; the second entry chronicles his "Die im Bernstein befindlichen organischen Reste . . . gesammelt . . ." The separate papers in this work are fully plotted out, and thus we have an entry concerning five works, of which the ordinary catalogues merely give the covering title. Let us now refer to BUFFON. We find no less than ten editions of his "Complete Works," of which two, if not three, are not to be found elsewhere in England, all of which are fully listed out, and the date for each volume of each series inserted. Even the "Guides des Excursions" of the Geological Congresses held at Zurich and St. Petersburg are fully listed as to their separate papers. With regard to those troublesome publications which are issued a few pages at a time and extend over a term of years, afterwards to be bound up as an ordinary book, and all records of date lost, Mr. Woodward has, whenever possible, either supplied the facts himself or given a note as to where they may be found. Many of these entries, occupying but a few lines of print, may mean hours, days, or weeks of hunting of the most wearisome description through contemporary literature. In this connection he has inserted a great deal of the matter collected by the writer while compiling his "Index Animalium." The irritating practice of authors of using one only of their christian names, or of using their surname hyphened to the last christian name without legal title, or of using the surname only, have all been dealt with, and many errors of this nature that have unavoidably crept into earlier catalogues have now been cleared up. We no longer read such a jumble as the fertile mind of an Indian babu elaborated for the catalogue of a well-known Indian library:—

BUFFON, de.
———, Le Citoyen la Cepède.
———, le Comte de.
———, le Comte de la Cepède.
———, le Clerc de.
See also Lacepède,

and though we have searched minutely for errors of any kind in the work before us, they are not only rare, but of trivial importance.

Among other important things from a bibliographical point of view, are the careful distinction between President and Respondent in the older Dissertations; the fact that the title is an exact transcript of the original so far as it goes, omissions being recorded by " . . . ", and additions being made in square brackets; and the transliteration and translation of Eastern titles.

We have brought thus fully to our readers' notice this catalogue of books because we feel that in these days of strain every solid step in the ladder of help is worth recording, and there is so much here that will save the time of the geologist, and the zoologist, whether he cares to deal exclusively with fossil or recent animals, or both. Its value also to small or incomplete libraries is almost beyond expression. At all events, when considering the date of a book or part of a book, or the proper name of an author, or the exact form of a publication (whether separate or an extract from an Academy or Serial), it will be found in future absolutely necessary to see what Mr. B. B. Woodward has had to say upon the matter in his "Catalogue of the Books, etc., in the British Museum (Natural History)." C. D. S.

II.—The Origin of Lake Tanganyika.

The Tanganyika Problem: an Account of the Researches undertaken concerning the Existence of Marine Animals in Central Africa. By J. E. S. Moore, F.R.G.S. pp. xxiv, 371, with text-figures, maps, and plates. London: Hurst & Blackett, 1903.

IN 1857 the late Dr. S. P. Woodward described two univalve shells of a remarkably marine aspect from Lake Tanganyika. In 1881 Mr. Edgar A. Smith announced the discovery of several other specimens of obviously marine relationships in the same lake. The German traveller, Dr. Böhm, subsequently found Medusæ with these shells, and when they were examined they were found to be quite unlike any known forms and probably of an ancient type. The freshwaters of Lake Tanganyika were therefore suspected to contain the relics of an ancient marine fauna, the lake itself, indeed, being the altered remnant of a former sea.

To investigate the problems thus suggested Professor Ray Lankester and a small committee organized an expedition, which was despatched under the leadership of Mr. J. E. S. Moore in the Autumn of 1896. The results of their investigations, communicated to the Royal Society and to various scientific journals, were so important that a second expedition was organized under the same leadership in 1899. A remarkable work was accomplished, and Mr. Moore has summarized the principal facts and conclusions in the beautiful volume now before us. The results of a purely scientific investigation have rarely been presented in so attractive a form, illustrated not merely with artistic drawings of the animals, but also with the author's own coloured sketches of the scenery.

It is evident that if Lake Tanganyika is a remnant of an ancient sea, many of the problems connected with it are essentially

geological. Although the work is that of a zoologist, it thus presents many features of great interest to readers of this Magazine. In attempting to study it, they will only regret that, while the author recognizes and discusses the geological bearings of the subject, he displays such a lack of acquaintance with the elementary principles of the science that the result is not so satisfactory as could be wished.

By way of introduction, Mr. Moore devotes a chapter to the origin of fresh-water faunas in general, and considers that the more widely-spread members of these faunas were all derived from the sea at one time—"at a period roughly corresponding to the commencement of the formation of the Secondary rocks." He thinks that increasing salinity of the sea-water caused this migration. The more strictly local fresh-water types are regarded as being of comparatively recent origin.

The special case of Tanganyika is then discussed, firstly from the geological and geographical point of view, and secondly from the zoological standpoint. No new geological facts of importance are recorded, but an interesting summary of the work of previous observers is given. The peculiar 'gräben' or 'rift-valleys,' so characteristic of the Tanganyika region, are unnecessarily renamed 'eurycolpic folds.' The Permo-Carboniferous rocks discovered by the late Professor Drummond on the shores of Lake Tanganyika are also misunderstood, and assumed to be marine sediments. In fact, there is at present no foundation for Mr. Moore's statement "that at some time there was in this region a fauna consisting at any rate of ganoid fishes, echinoderms, and molluscs, or, in other words, a marine fauna; and that these things entirely disappeared through the great physical changes and displacement which occurred during the extension of the Nyassa fold into this particular area." If truly marine deposits exist in the region in question they still remain to be discovered.

The most important zoological result of Mr. Moore's researches is, that although he made large collections he never found the supposed marine shells and medusæ in any lake except Tanganyika, while he did not discover any striking new types, except possibly a Polyzoan which has not yet been fully investigated. This circumstance is all the more remarkable since Mr. Moore obtained nearly 200 new species of animals referable to the typical modern fresh-water fauna of Africa. The fishes, described by Mr. Boulenger, and beautifully illustrated, are especially noteworthy, for they are all essentially present-day types, and do not in any way represent survivors from the seas of the Secondary period.

The precise affinities of the medusæ are still to be determined, but Mr. Moore has examined the anatomy of the univalve molluscs in great detail and with remarkable skill. He concludes that the characters of the shell afford a very slight clue to the true relationships of the animal to which it belongs. We can thus place little reliance on his interesting comparison of the univalves of Lake Tanganyika with certain shells of similar shape and ornamentation from the Jurassic rocks of England. His beautiful illustrations,

however, show that there is a most striking resemblance between the recent and fossil shells to which he refers.

Mr. Moore describes these univalve mollusca, the medusæ, and certain more doubtful animals as a "halolimnic fauna"—a stranded relic of an old marine fauna which has been little changed by isolation. He accounts for their presence by supposing that Tanganyika was connected with the sea during some part of the Secondary period by way of the Congo basin. There still remains, however, the difficulty that the halolimnic fauna is not found either in the neighbouring lakes or in the old sediments which have been examined round their margins. We are, indeed, greatly indebted to Mr. Moore for stating the Tanganyika problem more clearly and definitely than it was ever done before, rather than for proposing an adequate solution of it.

III.—Mathematical Crystallography and the Theory of Groups of Movements. By Harold Hilton, M.A. 8vo; pp. 262. Oxford: at the Clarendon Press, 1903.

AT the last Oxford Meeting of the British Association, held in the year 1894, the President of the Geological Section attempted to explain in simple language some of the most important recent developments of the theories of crystal-structure, then only on record in isolated memoirs, almost all of them foreign. Mr. Hilton, in the present work, has taken the same problem in hand; he has collected for the benefit of geologists and others the results obtained by Fedorow, Schönflies, and Barlow, and has arranged them in orderly sequence in twenty-six chapters. Beginning, in Part I, with a brief explanation of the stereographic projection, the author passes at once to the discussion of Homogeneity and the limited number (32) of finite groups of movements which are consistent with the law of rational indices and are therefore applicable to Crystallography; and then considers the dependence of the physical properties of crystals on the Symmetry. In Part II the author enters into the consideration of the Structure-theory. If a collection of molecules can be brought into self-coincidence by an operation, such an operation is termed a 'symmetry-operation'; all the symmetry-operations proper to the collection of molecules are said to form a 'group'; the author thereupon proceeds to evolve the 230 distinct groups which are geometrically, not necessarily mechanically, possible in homogeneous matter. Mr. Hilton next considers the regular partitioning of space, and mentions the interesting case in which space is partitioned by Lord Kelvin into 14-walled cells, all of them similar and similarly orientated, the walls being not in general plane. A final chapter gives a history of the Structure-theories. The book is illustrated with no fewer than 188 figures, some of them of a remarkably complicated character. Everyone interested in crystals will feel deep gratitude to Mr. Hilton for having so successfully undertaken a very difficult task, and to the University Press for having in this praiseworthy way made the work immediately accessible to the student.

REPORTS AND PROCEEDINGS.

I.—The Norfolk and Norwich Naturalists' Society, Norwich.

Address by the President, Henry Woodward, LL.D., F.R.S., V.P.Z.S., F.G.S., Late Keeper of Geology, British Museum, to the Members of the Norfolk and Norwich Naturalists' Society, at their Thirty-fourth Annual Meeting, held at the Norwich Castle Museum, March 31st, 1903.[1]

After some preliminary matters relating to the affairs of the Society, the President read his anniversary address, entitled "The Distribution of Life in Antarctic Lands."

Introductory—Glacial and Interglacial Periods.—During the past sixty years astronomers, physicists, meteorologists, and geologists have all laboured to elucidate the causes and extent of the *Glacial period,* or, to speak more correctly—*periods.*

It seems certain that such epochs have been, in great measure, brought about by a combination of astronomical causes, such as the inclination of the earth's axis, the ellipticity of her orbit, and her position in relation to the sun in perihelion and aphelion. But to whatever combination of causes such alterations of climate in the northern and southern regions of our globe may be due, we have a right to demand from the astronomers and physicists the concession that mild Interglacial periods of considerable duration must have prevailed at or near the poles, certainly within Tertiary times. Sir Robert Ball says: "It is essential to the astronomical theory of the Ice Age that such interglacial and glacial periods must have alternated with one another at the opposite poles of our earth."

The facts of the occurrence of extensive beds of coal and lignite, associated with shale-beds rich in leaves of dicotyledonous trees and shrubs in Arctic America, in North Greenland, Spitzbergen, etc., within the Arctic circle; and beds of coal with abundant tree-trunks in Kerguelen Island,[2] Chatham Island,[3] etc., in the Antarctic, where no trees now exist, testify to great changes of temperature in the circumpolar regions of our earth, such as would, if they recurred, render these lands again habitable by plants and animals belonging to warmer temperatures, and greatly reduce, if not entirely remove, all traces of snow and ice over these areas.

Let us take a glance at the two polar regions of our earth. First: let us note the fundamental difference between Arctic and Antarctic conditions as regards topography. In the Northern Hemisphere there is a polar sea almost completely surrounded by continental land, and continental conditions for the most part prevail. In the Southern Hemisphere there is almost certainly a continent at the South Pole, which is completely surrounded by the ocean, and the most simple and extended oceanic conditions are met with.

[1] Reprinted from the Transactions of the Norfolk and Norwich Naturalists' Society, vol. vii, pt. 4, and issued to members 20th August, 1903.

[2] 50° S. lat. Kerguelen Island.

[3] 45° S. lat. Chatham Islands.

Below the parallel of 40° South latitude lie Tasmania, the South Island of New Zealand, numerous small islands (such as the Chatham Islands, Auckland Island, Campbell Island, Macquarrie Islands, Kerguelen Island, Heard Island, Prince Edward Islands, Tristan da Cunha, Gough Island, Bouvet Island, South Georgia, Sandwich Group, South Shetland and South Orkney Islands, Falkland Islands), and about 1,500 miles linear of the South American Continent, Tierra del Fuego and Cape Horn. At the pole itself lies the great unexplored Antarctic Continent, surrounded by the vast waters of the Southern Ocean, covering an area of 30,000,000 square miles.

Atmosphere. — Over the area, south of the parallel of 50° S. latitude, a temperature below 32° Fahr. prevails. South of latitude 45° S. we meet with low atmospheric pressure all the year with strong westerly and north-westerly winds, and large rain and snowfall all round the South Polar regions, the mean pressure being less than 29 inches. But there are many indications that the extreme South Polar area is occupied by a vast anticyclone, out of which winds blow, towards the girdle of low pressure outside the ice-bound region. Ross found a gradual rise of pressure south of latitude 75° S., and all Antarctic voyagers agree that when near the ice the majority of winds are from the south and south-east, and bring clear weather with a fall of temperature, while northerly winds bring thick fogs with rising temperature.

Antarctic Ice.—The most striking feature of the Antarctic is the huge table-shaped icebergs. These flat-topped icebergs have a thickness of 1,200 to 1,500 feet, marked by regular stratification, and presenting lofty perpendicular cliffs, which rise 150 to 200 feet above, and sink 1,100 or 1,400 feet below the level of the sea.

Their form and structure clearly indicates that they were formed on an extended land surface, and have been pushed out over low-lying coasts into the sea.

Ross sailed for 300 miles along the face of a great ice-barrier from 150 to 200 feet high, off which he obtained depths of 1,800 and 2,400 feet. This was evidently the sea front of a great creeping glacier or ice-cap just then in the condition to give birth to those table-shaped icebergs, miles in length, which have been described by every Antarctic voyager.

But all the Antarctic land is not surrounded by inaccessible cliffs of ice, for along the seaward face of the great mountain ranges of Victoria Land the ice and snow which descend to the sea apparently form cliffs not higher than ten to twenty feet; and in 1895 Kristensen and Borchgrevink landed at Cape Adare on a pebbly beach, occupied by a Penguin rookery, without encountering any land-ice descending to the sea.

Where a Penguin rookery is situated we may be quite sure that there is open water for a considerable portion of the year, and consequently landing might be effected without much difficulty or delay. A party once landed might with safety winter at such a spot, where Penguins would furnish an abundant supply of food and fuel.

A properly equipped party of observers situated at a point like this on the Antarctic Continent for one or two winters might carry out a most valuable series of observations, make successful excursions towards the interior, and bring back valuable information as to the probable thickness of the ice-cap, its temperature at different levels, its rate of accumulation, and its motion. As to the evidence of an Antarctic Continent, the form and structure of the Antarctic icebergs show that they were built up on and had flowed over an extensive land surface. As they float north and break up in warmer latitudes they distribute over the floor of the ocean large quantities of glaciated rock-fragments and land detritus.

These materials have been dredged up by the "Challenger" in considerable quantities, and show the rocks of this land to be gneisses, granites, mica-schists, quartz-diorites, sandstones, limestones, and shales; indicating continental land, and were clearly transported from land at the South Pole.

Rocks.—D'Urville describes rocky islets off Adélie Land composed of granite and gneiss. Wilkes found on an iceberg, near the same place, boulders of red sandstone and basalt. Borchgrevink and Bull fragments of mica-schists and other continental rocks from Cape Adare. Dr. Donald brought back a piece of red jasper or chert containing Radiolaria and Sponge spicules from Joinville Island. Captain Larsen brought from Seymour Island pieces of fossil coniferous wood, and fossil shells of *Cucullœa*, *Cytherœa*, *Cyprina*, *Teredo*, and *Natica*, having a close resemblance to species of lower Tertiary age in Patagonia, etc. These fossil remains indicate a much warmer climate in these areas in times past.

It is not to be expected that a living land-fauna will now be discovered beyond the Penguin rookeries. *Fossils* will, however, throw important light upon the age of the Antarctic land.

As Tertiary, Mesozoic, and Palæozoic fossils have been freely met with in Arctic regions, we are justified in anticipating the discovery of like forms on the Antarctic lands, with corresponding former climatic changes, such as the presence of these forms of life would demand.[1]

Kerguelen Islands, Lat. 49° 20′ S., Long. 69° 24′ E.—In Sir James Clark Ross's voyage to the Antarctic (1847, 2 vols., Murray), he visited the Island of Kerguelen in 1840, and records the occurrence of a bed of coal, four feet thick and 40 feet in length (exposed), near Arched Point, Christmas Harbour, 30 feet above the sea, and covered by basalt. On the north side of the bay formed by Cape François is a thin seam of coal (two or three inches in thickness) covered by a kind of 'slag' and by basalt. Silicified trunks of trees are also met with, some of which (brought home by Sir Joseph Hooker) are preserved in the British Museum.

The coal is described as slaty, of a brownish-black colour, and the fracture is like wood-coal. Both the wood and the coal-seam are probably of Tertiary age. (A trunk of a large tree, seven feet in

[1] See Sir John Murray, Proc. Roy. Soc., vol. lxii (1898), pp. 424–451.

circumference, and much silicified, was dug out of soil below the basalt.) The wood, which for the most part is highly silicified, is found enclosed in the basalt, whilst the coal crops out in ravines, in close contact with the overlying porphyritic and amygdaloidal greenstone.

Ross mentions another bed of coal in Cumberland Bay, one foot in thickness (light and friable with a black glossy fracture like cannel coal, which does not soil the fingers). It is covered by a porphyritic amygdaloidal and greenstone rock. Another bed of coal in an adjacent hill is two feet thick, of a dull brownish-black colour; and it is said to burn very well.

When Captain Cook visited Kerguelen in the height of Summer (1768) the land was covered with snow, and only five plants in flower were collected. The observations were made by Surgeon Robert McCormick and Assistant-Surgeon Joseph D. Hooker, of the "Erebus" (1839–43). Hooker records 150 living plants—18 flowering plants, 3 ferns, 25 mosses, 10 *Jungermanniæ*, 1 fungus, the rest (93) lichens and seaweeds.

Mr. R. McCormick, who accompanied Ross, wrote:—"Since the successive overflowings of volcanic matter destroyed the forests which at one period clothed this land, of which the fossil trees and numerous beds of coal afford abundant proof, it has remained in a state of almost vegetable desolation ever since."

Writing of Victoria Land, Sir James Ross in February, 1841, said: "Had it been possible to have found a place of security upon any part of this coast where we might have wintered in sight of the brilliant burning mountain (*Erebus*), and at so short a distance from the magnetic pole; both of these interesting spots might easily have been reached by travelling parties in the following Spring. It was, however, some satisfaction to know that we had approached the pole some hundreds of miles nearer than any of our predecessors."

And here I may record that on March 26th, 1903,[1] Relief Ship "Morning" sends us good news from Port Lyttelton, New Zealand; and we know that Commander Scott with his crew in the "Discovery" entered the Antarctic Ice-pack on 23rd December, 1901, lat. 67° South, reached Cape Adare on 9th January, 1902, Wood Bay on 18th January, and landed on 20th in an excellent harbour, lat. 76° 30′ South, visited Cape Crozier on 22nd, examined the ice-barrier, and took soundings in long. 165°, and found that the ice-barrier trended northwards. High snow slopes rose towards the glaciated lands with occasional bare precipitous peaks. They followed the coast as far as lat. 76°, long. 150° 30′; and then retired to winter quarters in McMurdo Bay, Victoria Land. Sledge-parties reached lat. 80° 17′ South, the furthest point ever attained. Ranges of high mountains were seen to continue through Victoria Land. Foothills resembling the Admiralty range were observed at 160°. Lowest temperature 62° below zero!

[1] Fuller details are now before the public since the date of this address, March 31st, 1903, which, however, was not issued until 20th August, 1903, in vol. vii of Trans. N. & N. Nat. Soc., Norwich.

Dr. J. W. Gregory, F.R.S. (*Nature*, April 25th, 1901), following Bernacchi's "Topography of South Victoria Land" (Roy. Geog. Soc., March 18th, 1901), suggested various problems for the "Discovery" to work out.

(*a*) Whether the Antarctic lands to the south of Australia, Victoria Land, Wilkes' Land, Adélie Land, Geikie Land, Newnes Land, Termination Land, are all part of one great continent, or members of an Antarctic Archipelago.

The earlier voyagers all maintained the existence of an Antarctic Continent, and Suess' theory supports this view.

Ritter suggests that the volcanic chain forming the eastern face of Victoria Land is the continuation of the New Zealand volcanic line, and that the coast of Wilkes' Land is a southern extension of the Australian plateau. This plateau is bounded to the north and east by the great fold passing through New Guinea, New Caledonia, and New Zealand.

The rocks dredged by the "Challenger" and the "Valdivia" are like those of Southern Australia; and those of Victoria Land, examined by Teall, are like the rocks of New Zealand. Geologically, then, the Antarctic is an Archæan land with rocks similar to those of Australia; and its eastern side is volcanic.

Indirect evidence favours a land connection with a chain of peaks stretching from Victoria Land and the vicinity of Mounts Erebus and Terror to Graham's Land.

If this great line can be proved, the volcanic chain encircling the Pacific Ocean will be rendered complete, joining up the Antarctic land with New Zealand and Australia on the one hand, and Graham's Land to South America on the other. We do not expect a land fauna on the Antarctic, but Secondary and Tertiary fossils may be discovered, and furnish still further evidence of an old land connection.

Correspondence in North and South Conditions, or 'Bipolarity,' and Bipolar Faunas.—There is an interesting question, too, in reference to the littoral and shallow-water fauna and flora of the Antarctic lands as compared with the Arctic.

The *Sirenia* are represented in the south by *Halicore australis*, off the coast of Queensland, Australia, 30° only south of the equator, whilst *Rhytina gigas* (= *R. Stelleri*) occurs in peat-deposits on Behring Island, and was living in numbers around its shores as lately as 1750, 60° north of the equator. Probably in earlier times *Halicore*, or its allies, may have extended southwards to the shores and islands of the Antarctic lands.[1]

Of the Cetacea, the genus *Balæna* is represented in the Arctic seas by *B. mysticetus*, *B. Biscayensis* occurring in the North Atlantic and *B. Japonica* in the North Pacific, the South Atlantic having *Balæna australis*, and the South Pacific *B. antipodarum* and *B. Novæ-Zealandiæ*.

[1] According to Ross and many other explorers, great banks of *Laminaria* and other seaweeds, similar to those around Behring Island, on which the *Rhytina* fed, abound in the South Polar seas.

Of the *Pinnipedia*, Seals and Walruses, the Northern Sea Lion, *Otaria Stelleri*, the largest of the genus, ten feet long, from the North Pacific, is represented by *Otaria jubata*, the Patagonian and Southern 'Sea Lion,' and some other corresponding species as *O. Californiana* (California) and *O. ursina*, North Pacific, Prybiloff Island; *O. pusilla*, Cape of Good Hope; *O. Forsteri* and others from Australia. The Walrus (*Trichechus*) is only found in the Arctic seas, North Atlantic, and North Pacific Oceans. The true Seal (*Phoca*) is common to the North Atlantic and the North Pacific coasts, but does not occur in the Southern Ocean.

The 'Sea Leopard,' *Ogmorhinus*, occupies the Antarctic and Southern temperate seas. The Elephant Seal (*Macrorhinus*), or Sea Elephant, the largest of the whole family (twenty feet long), was formerly abundant in the Antarctic seas and also found on the coast of California. The Hon. Walter Rothschild lately obtained one, at great expense, and presented it to the National Museum.

The Penguins (Impennes) may be said to represent in the Southern Ocean the Auks and Divers of the Northern seas.

Whether these are all (as the Penguins and Auks are) merely representative forms, or whether they may have in some cases been able to cross the equatorial region and reach the Arctic from the Antarctic, is an open question. Certain deep-sea water forms of Crustacea may have done so along lines of cold currents in the ocean, but this does not so easily explain the presence of shore and surface-dwelling forms of life having a common facies, if not an actual close family relationship. Still, it must be borne in mind that cold polar currents do reach near to the equator on the South American Chilian coast. The Sea Lions and the Elephant Seal have thus, in all probability, been enabled to "cross the line."

Antarctica in connection with the neighbouring Land-Areas.—Fifty years ago there were very few men of science bold enough either to suggest or to accept the theory that the geographical distribution of plants and animals had actually commenced far back in past geological time.

Professor Edward Forbes, S. P. Woodward, Darwin, Wallace, Huxley, Sclater, Blanford, H. O. Forbes, and others have advocated these views, but they have become greatly modified in our own day since the time at which they were first expressed.

Australia was deemed to be a survival from the Jurassic period, New Zealand from the Triassic, and so on.[1] Australia is now known to possess representatives of almost every formation from Cambrian and Silurian times to the Tertiary. The fact remains that the flora and fauna of Australia and New Zealand present remarkable characteristics which, until lately, were believed not to exist on any other part of the earth's surface.

[1] The great Struthious (wingless) birds of New Zealand were formerly supposed to be the descendants of the makers of the tridactyle footprints left upon the slabs of Triassic sandstone in the Connecticut Valley and elsewhere. These footprints have been described by the late Professor O. C. Marsh, and shown to have been left by bipedal Dinosaurian reptiles, which were living in the Triassic period, before birds had made their appearance.

In favour of a Southern connection of Antarctic Lands.—A. R. Wallace, in "Island Life," says:—"Whenever we find a considerable number of the Mammals [or flightless birds] of two countries that exhibit distinct marks of relationship, we may be sure that an actual land-connection, or a close approach to one, has at one time existed."

Charles Darwin ("Origin of Species," vol. ii, 1888, p. 190), says:—"New Zealand is plainly related to South America, although the next nearest continent is so enormously remote that the fact becomes an anomaly. This difficulty disappears in the view that New Zealand, South America, and the other Southern lands have been stocked in part from the Antarctic Islands, when they were clothed with vegetation during a warmer Tertiary period, before the commencement of the last Glacial epoch."

Dr. W. T. Blanford, F.R.S. (Pres. Geol. Soc., 1890), wrote in his address:—"The biological evidence of a former land connection between South America and Africa is very strong, and if the difficulty about the depth of the intervening ocean is overcome, there is no improbability in the suggestion that, at some period of geological history, an important continent having connections with South America, South Africa, and New Zealand, may have occupied the Antarctic Area."

Professor Huxley, "On the Distribution of Gallinaceous Birds," P.Z.S., 1868, says:—"Of the two sections (the *Alectropodes* and the *Peristeropodes*), the former are restricted to the Northern, and the latter to the Southern Hemisphere." He goes on to compare the Curassows of South America with the Megapodes or Mound-builders of Australia; and he considers that they are sprung from one stock; and that the common ancestors must have developed on some large area in the Southern Hemisphere, from which there was access both to South America and Australia.

It is probable that a very large extent of ancient land around the present Antarctic continent has been lost to us by submergence, and that the rather numerous small islands in the surrounding ocean are but the buoys or landmarks indicating large areas of more or less continuous land, which has since disappeared. This is supported by the many signs of volcanic activity in recent times which these islands display. Doubtless land connections stretched from South America to the South Shetlands, the South Orkneys, South Georgia, and to Kerguelen Island.

Peculiarities of Southern Land-Faunas.—Let us look for a moment at the peculiarities of the Southern land-faunas:—

In no other part of the world do we find such a remarkable assemblage of struthious birds, both of living and extinct forms, distributed over the continents and islands which encircle the Antarctic. In South America we have the *Rhea Americana*. In Africa the Ostrich *Struthio camelus*. In Mauritius we have numerous (8) species of *Æpyornis* (an extinct wingless bird as large as the *Dinornis* of New Zealand), remarkable also from the great size of its eggs. In Mauritius we find the extinct Woodhen *Aphanapteryx*.

In Rodriguez nearly the same form, *Erythromachus*, was also once common. In Australia we have the Emeu and Cassowary living, and the extinct *Dromornis* and *Genyornis*. In New Zealand about twenty species of *Dinornis*, or 'Moa,' the largest attaining a height of at least twelve feet, were once most abundant, and peopled both islands (as the presence of their bones everywhere testifies), but have now been entirely exterminated by the Maoris, as the similar large bird, the *Æpyornis*, was destroyed by the natives in Madagascar. The surviving form is the 'Kiwi' or *Apteryx*, which is also found fossil (*Diaphorapteryx*) in the Chatham Islands 500 miles to the east of Port Lyttelton, New Zealand. *Cabalus*, a flightless Crake, akin to the Woodhens, also survives in the Chatham Islands. This *Cabalus* occurs also on Lord Howe Island, 300 miles off the coast of Eastern Australia to the far north-west of Chatham Island.

Of other flightless birds, we have the *Aptornis defossor*, a large extinct Rail, and Mantell's *Notornis*, recently killed off in New Zealand, a *Porphyrio* also in New Zealand and Norfolk Island.

The Penguins, of which many species are known, occur on the islands and continents of all the Southern lands, just as the Great Auk was at one time distributed around all the circumpolar lands in the Northern Hemisphere, but the Great Auk was not found within the Arctic circle.

Australia possesses a peculiar existing fauna belonging to the *Monotremata* and *Marsupialia*. The former: *Ornithorhynchus* and *Echidna* represent the sole surviving forms of the lowest division of the Mammalia, viz. the Prototheria, and to the order *Monotremata* (egg-laying Mammals), which are confined to Australasia (New Guinea, Australia, and Tasmania). The latter comprising the pouched Mammals, known as the Kangaroos, Wombats, Dasyure, Thylacine, Rat-Kangaroo; *Macropus*, Rock-Wallabies (*Petrogale*), Hare-Wallaby (*Lagorchestes*), *Dorcopsis*, *Dendrologus* (Tree-Kangaroo); *Bettongia*, etc.

Fossil forms are numerous, some like *Diprotodon* and *Nototherium* far exceeding the living forms in size. There are also many other fossil genera, described by Owen, such as *Sthenurus*, *Procoptodon*, *Palorchestes*. In *Diprotodon* the fore and hind limbs are not differentiated, but are of nearly equal length and not adapted for rapid movement. Added to these are the Phalangers, Cuscus, Flying Phalangers; the Koala; and the *extinct Thylacoleo carnifex*, most probably related to the Wombats (*Phascolomys*). Added to these are the Bandicoots (*Perameles*); the Tasmanian Wolf (*Thylacinus*); the Tasmanian Devil (*Dasyurus*); the Pouched Mole (*Notoryctes*); and the Opossums (*Didelphys*), these last being common to America and Australia.

The curious and now almost extinct 'Tuatara' Lizard (*Sphenodon* or *Hatteria*), now confined to an islet off the North Island of New Zealand, formerly existed also in Chatham Islands 500 miles distant by sea.

The most remarkable discovery of late years bearing upon the wide distribution of similar animals over the Southern continents

is that of *Miolania*, an extinct genus of land Tortoise, the head of which is ornamented with peculiar bony plates, and the tail is encased in a bony sheath, resembling the tail of *Glyptodon*. The first example of *Miolania* was found in Queensland, Australia; the second on Lord Howe Island, 300 miles to the eastward of the Great Barrier Reef. The third example was lately obtained by Dr. Moreno in Argentina, South America! yet they can only be differentiated specifically, notwithstanding their enormously wide geographical separation from one another.

Amongst the Amphibia the *Cystognathidæ* occur in Australia, Tasmania, and South America. Of fresh-water fishes we have the Southern 'Salmon' *Haplochitonidæ*, and the Southern Pikes *Galaxiidæ*, common to New Zealand, Chili, Patagonia, and the Falkland Islands. Again, the remarkable *Dipnoi* and *Osteoglossi* are peculiar to the rivers of Africa, Australia, and South America, and are unknown north of the equator. *Peripatus* is only known from the West Indies, from South America, South Africa, and Australia. Among the *Scorpionidæ*, the genus *Cercophonius* is only met with in South-East Australia and in South America. *Placostylus*, a genus of land Mollusca, is found in the Solomon Islands, in Fiji, the New Hebrides, Loyalty Island, New Caledonia, Norfolk Island, Lord Howe Island, and in New Zealand.

A summary of the flora characteristic of the Southern Hemisphere fully confirms the conclusions derived from a study of the fauna, and establishes beyond a doubt the former existence of extensive land connections between the Southern continents and islands in Tertiary times which have since disappeared beneath the ocean.

Plantæ. Southern Hemisphere (*Notogæa*).—Saxifrageæ. Of the 'Saxifrages' the genus *Donnatia* occurs in New Zealand, Tasmania, Chili, and Tierra del Fuego. *Escallonieæ*, 17 genera met with in New Caledonia, Australia, and Tasmania. *Cunoniæ*, 18 genera common to New Zealand, Mascarene Islands, South Africa, and South America. Only two out of thirty-five genera cross the equator into the Northern Hemisphere.

Proteaceæ. The *Banksias* have 49 genera and 950 species. Only 25 cross the equator. The others belong to Madagascar, Tasmania, New Zealand, and New Caledonia. Some occur fossil in Miocene and Cretaceous Plant-beds in Europe.

Monomiaceæ (related to the Laurels), 22 genera and 150 species, have the same distribution as above. One genus, *Laurelia*, is common to Chili and New Zealand.

Perseaceæ, the genus *Cryptocarya*, is common to New Zealand, South Africa, and South America.

Coniferæ, *Callitris*, is common to Africa, Madagascar, Australia; *Fitzroya* is common to Chili and Tasmania.

Podocarpeæ, 3 genera; distributed 1 in Tasmania, 1 in Chili and South America, and 1 South Africa, Australia, and New Zealand.

Todea barbara occurs at the Cape of Good Hope and in Australia.

Lomaria Alpina occurs at the Cape, in Australia, and South America. *Fuchsia* and *Passiflora* are common to New Zealand and

South America. New Zealand and South America have 74 genera of plants in common, 11 identical, and 32 closely allied species.

That earth-movements, on a widely extended scale, have occurred in the South, is evidenced by the very late elevations and subsidences which have taken place in parts of the Andean chain and in Tierra del Fuego, also in Kerguelen Island, Eastern Australia, Tasmania, New Zealand, and the Chatham Islands; whilst the vast upheaval of the Himalayan range itself is only of newer Tertiary age.[1]

P.S.—Those who are interested in following up the suggestions of this Address and inquiring further as to the special members of the fauna and flora of the Southern lands and their inter-relations, will do well to consult Dr. H. O. Forbes' paper read before the Royal Geographical Society, March 13th, 1893, entitled: "The Chatham Islands: their relation to a former Southern Continent" (Supplementary Papers Royal Geographical Society's Journal, vol. iii, part 4, 1893, pp. 607–637), to which the author desires to acknowledge his indebtedness for many interesting facts recorded by him.—H. W.

II.—The Meeting of the Museums Association at Aberdeen, July 14–17, 1903.

The fourteenth annual meeting of this useful body took place during July in Aberdeen, under the presidency of Dr. F. A. Bather. Although the place of meeting was more remote than any yet chosen, the number of members attending was larger than on any previous occasion. The meeting was further noteworthy for the presence of three delegates from foreign museums, while no less than six of the papers read were sent from abroad, also for the fact that a delegate was officially sent from a Government department—the Board of Education.

The work of geological museums, as such, did not receive much attention; but the President was doubtless speaking from experience gained in the Geological Department of the British Museum when he suggested that the time had come to go beyond the hitherto recognised division of public collections into a reserve or study series and an exhibited or public series, and to arrange such collections in three series, namely, (1) for specialists and researchers, not exhibited but kept under lock and key or in private workrooms; (2) for students and collectors, exhibited under glass or in special cabinets open to students, but not elaborately mounted, and accessible only on demand; (3) for the man in the street, selected specimens beautifully mounted so as to make the utmost appeal to the lay public.

Dr. Anton Fritsch, of the Bohemian Museum, Prague, contributed a study of "The Museum Problem in Europe and America," giving

[1] Dr. Woodward's address was illustrated by about fifty-eight lantern slides, a great number of which were beautifully painted pictures of birds by Keulemans, kindly lent by Dr. H. O. Forbes, Director of the Liverpool Museum, and a series of Arctic views and maps kindly lent by the Royal Geographical Society, besides a number prepared expressly for his address by Dr. H. Woodward.

to his hearers a number of hints collected during his recent travels. Mr. B. H. Woodward, F.G.S., described "The Western Australian Museum and Art Gallery, Perth," of which he is the energetic curator. Mr. Jeffrey Bell advocated more attention to "Good Form in Natural History Museums," especially as regards harmonious arrangement of cases, colour of background, colour of labels, and the use of technical terms, which, in his opinion, should be avoided in exhibits intended for the public. Professor J. Arthur Thomson urged the need for a faunistic museum for the North of Scotland. Mr. S. S. Buckman, in a paper entitled "Neglect of Opportunities," indicated certain methods by which the relation of biological and geological science to human ideas and needs might be better brought out in the public galleries of natural history museums; in particular he showed how details of palæontology might be relieved of their dryness by being paralleled with the facts of man's individual and social life. These and the other papers which were read will appear *in extenso* and adequately illustrated in the third volume of *The Museums Journal*.

It was unfortunate that the week chosen for the meeting should have been that when the University authorities were inevitably engaged with the Degree examinations. In spite of much inconvenience to themselves, they kindly admitted members to their picture galleries and scientific museums. The Zoological Collection was described by Professor J. A. Thomson, and the Geological Collection by his assistant, Mr. A. Willard Gibb, M.A. The latter was arranged by the late Professor H. Alleyne Nicholson, LL.D., M.A., F.R.S., F.G.S., to whose memory a medallion portrait with a decorative design in selected Palæozoic fossils, accompanied by a suitable inscription worked out as a repoussé brass tablet, has been placed on the wall of the College Chapel, designed by Miss Alice B. Woodward, and executed by Messrs. Ramsden & Carr of London.

The next annual meeting is to be held in Norwich under the presidency of Dr. S. F. Harmer, F.R.S.

CORRESPONDENCE.

THE BUDLEIGH PEBBLES—MARINE OR FLUVIATILE?

SIR,—In his paper on the Triassic Pebbles of South Devon, Mr. Shrubsole makes a most important statement as to the action of waves on the Budleigh Salterton pebbles. He asserts that "the result [of wave action] is to produce a new deposit altogether, in which the pebbles are usually of a totally different shape. They now become as a rule symmetrical, and lose all trace of angularity" (Q.J.G.S., vol. lix, p. 316). This is diametrically opposed to the following categorical statement of the late Mr. W. Pengelly: "It is worthy of remark, that the pebbles which have performed the modern journey from Budleigh Salterton to Pinney Bay, and those which remain in the bed in the former locality, are identical in form. Re-denudation and a transportation by waves over eighteen miles of